COLEOPHORA. (Tent-makers.)

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THE

INTELLECTUAL OBSERVER:

REVIEW OF NATURAL HISTORY,

MICROSCOPIC RESEARCH,

AND

RECREATIVE SCIENCE.

VOLUME IV.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS ENGRAVINGS ON WOOD.

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THE INTELLECTUAL OBSERVER.

AUGUST, 1863.

MICRO-LEPIDOPTERA.
(COLEOPHORA, OR TENT-MAKERS.)

BY L. LANE CLARKE.

(*With a Coloured Plate.*)

If these summer months are favourable for the study of leaf-mining caterpillars, and the abundance and variety of their hieroglyphics arrest our eye in every walk, and give new specimens for our cabinet, not less so are these months, from June to October, for collection of the curious and interesting Coleophorum. The moths themselves are not nearly so beautiful as the *Nepticulæ* and *Lithocolletis;* the wings are lanceolate, unicoloured, or striped with silken-gray under-wings, and they sit with bodies closely pressed to the substance on which they rest, with antennæ thrown forward, much like the *Tischeriæ.*

The larvæ of this genus are the objects of our present research and interest, because their habits manifest an instinct and design which open for us a delightful field of observation. They feed upon the parenchyma of leaves, and mine irregular blotches as they feed; but with the cuticle, or leaf itself, or husk of seed, it fashions a tent, under which it walks about, and within which it retires when the time of its pupa rest has come, and the resurrection into *perfect life* is at hand.

As a general rule for the guidance of young naturalists, when we find a blotched or mined leaf with a round hole, as truly outlined as if drilled with a centre-bit, we may be sure that a Coleophora has been feeding there, and this little hole was the entrance into his pasture-ground, covered closely by its tent, whilst the owner penetrated into the soft, juicy parenchyma, and stretched away, as far as its body would reach, on all sides, careful only to keep its anal hooks at the tent door to secure a retreat on the least alarm.

I have at this moment about twenty specimens of the Coleophora (*Limosipennella*) feeding on a branch of elm, in water, on my table, and one is under the binocular mining for its daily food; another I turned out of its pretty case that it might make a new one for my edification, and the verification of a former statement. Whilst it is uneasily walking about, wriggling its unhoused tail, and apparently measuring those serrated edges of the elm-leaf, I will give some particulars of the Coleophora as a genus of the Micro-Lepidoptera.

There are forty-one British species described by Stainton,* and many of them have been mentioned and figured by various naturalists, Reaumur, Curtis, Haworth, Duponchel, and our own Westwood, under the synonymes of Porrectaria, Ornix, Gracillaria, Astyages. At present they bear the very appropriate name of Coleophora, from *Kōleon* (a sheath), *Phoros* from *Phero* (to bear).

The larva of a Coleophora has sixteen legs; the prolegs are very undeveloped; the six true legs are pointed and scaly as those of large caterpillars. They have invariably dark spots on the anterior and anal segment, and a horny plate on the second segment, which I imagine to be used by the insect to smooth the asperities of the leaf, as it is observed to turn about and rub its head over every part of its case previous to lining it with silk. There is also a plate on the anal segment to protect that part from the friction to which it is exposed by the protrusion of the anal segment in voiding its excrement.

These tiny caterpillars, scarcely noticed by the unassisted eye, are wonderful in their instinct, as the *Lithocolletis* are marvellous in their beauty. Here is a mere speck, a little brown, naked worm, busy on the leaf before me; nothing can be more insignificant in appearance, or more unworthy of minute attention; hardly does the careless eye perceive it, and yet how the detail of its structure reveals the mind of its Great Creator; the same wisdom planning, and the same goodness adapting each organ for the tiny workman that has given to man his more perfect body.

Look closely at the larva itself before we describe its proceedings. Externally we observe a small black head, with six simple eyes in a circle on each side, a pair of sharp-toothed jaws, four little palps or feelers, and a spinnaret immediately under the jaws; six true legs and ten membranous appendages, thirteen joints or segments, and on each segment a spiracle dilating and contracting as the larva breathes and moves. At the anal segment there is a protuberance, armed with hooks, which it uses as a claw to attach itself to the leaf whilst making its case, and afterwards as a grappling-iron to retain possession

* Vol. iv. and v. of *Natural History of the Tineina*, by Stainton and Zeller.

of its tenement. So far, externally, we may pause to admire the adaptation of its body for its present phase of life; but, if taking advantage of the long and patient labours of Lyonnet, Dufour, Swammerdam, and other distinguished naturalists, we pass from the outward form to the internal mechanism of this minute creature, taking its various functions of respiration, circulation, nutrition, secretion, with sensation, and muscular action, one by one, into quiet, thoughtful consideration, far greater will be our appreciation and admiration of the little Coleophora before us.

Its *sensation* depends upon its nervous system, and that consists of a chief ganglion, or little brain, followed by twelve other little ganglia united by nervous cords, and giving out branches in pairs more numerous even than those of our own human body, for Lyonnet counted ninety of these branches in a caterpillar, and *we* have but seventy-eight.

Its *respiration* who can conceive? unless the eye has seen, under high microscopic power, the wonderful complexity and delicate tracery of the tracheal vessels which envelope and permeate the whole of the internal organs attached to the external spiracle, aerating and life-giving.

The *circulation* is provided for by the throbbing, no, not throbbing, but pulsating heart, which beats so strongly and evenly, sending the white, cold blood in steady current to and fro from chamber to chamber of the dorsal vessel, in each of which it receives exhilarating oxygen from the network of trachea surrounding it. The life of a larva is calm and unimpassioned, the instinct of self-preservation more developed than the instinct of reproduction; the calm pulsation of the silkworm is very different from the fluttering pulses of the silkworm *moth*.

Its *nutrition*. We may not give time to that, with all its elaborate arrangement of pharynx, œsophagus, crop, gizzard, biliary vessels, etc., etc., etc. Let us rather consider its *muscular* action, for it is very remarkable in our little tent-maker.

If any one has seen the preparation of the Cossus by Mr. Robertson, in the Oxford Museum, an illustration of Lyonnet's researches, proving the existence of 4,061 muscles in that caterpillar, 228 being attached to the head, 1,647 to the body, and 2,186 to the intestines—remembering that we have no reason whatever for denying the same number of muscular bands to the smallest larva, and that the Coleophora in particular has need of every kind of muscle in the fashioning and bearing about its tent, a feeling of positive awe steals over the mind. Every kind of muscle! Yes—levators, depressors, flexors, extensors, abductors, adductors, supinators, and pro-

nators. We need but watch the persistent action of those busy jaws to be very sure that its *abductors* and *adductors* are in perfection; whilst to twist about its spinnaret and weave the tapestry of its chamber, supinators and pronators must be in full play, as well as the ceaseless constrictor muscles, opening and closing the spiracles, and giving such varied movements to the segments of the abdomen. Would the dorsal vessel pulsate without that arrangement of muscular fibre, by which the systole and diastole is maintained? and would the peristaltic motion, so necessary to digestion, go on without that exquisite network of innumerable muscular threads, which twine along, and across, and around every internal organ? No; all this mystery of life goes on planned, directed, and sustained beneath the tegument of this microscopic worm.

Now what is the little larva about? I have placed it under the microscope; he has at length entered the leaf, and eaten more than the length and breadth of its body. I turned it out of its case at two P.M. It wandered restlessly until four P.M., then fixed and opened its circular door, slowly going forward, until on my return at ten P.M. it had advanced into perfect shelter. The next morning a large blotch was eaten, but I was in time to sit beside the elm branch and watch the making of the tent.

It had fixed near the edge of the leaf, and was carefully eating out the parenchyma of each serrature, leaving the edges untouched, as it thereby saved a seam in the tent, yet emptying each tooth to make it light and less brittle. When all was clear, the larva measured a gentle curve a little larger than its body, and began to draw the cuticle together on the opposite side to the serratures—tacking it loosely at first, and biting the membrane between the fibres, sewing it more neatly then, and careful not to cut the supporting braces formed by the nerves of the leaf. Then it rubbed the interior of the case with its head, as if to smooth it, and presently began to darken it with a web of fine silk, rendering further operations invisible, only I perceived that one end was left open for the ejection of its excrement, and that the fibres were cut mysteriously away, when the tent by powerful muscular action was raised from the leaf, and the Coleophora marched off to refresh itself in a new excavation.

Yet that was another point on which to rest and ponder. What was it eating, and how much did it eat?

What store of delicate and varied food lies in the cells of any leaf; sugar and starch and chlorophyll, oils and gums and raphides; ay, and in some plants, like the common nettle, beautiful crystals suspended from the cell wall, or floating about; sweetmeats and candies for the little gourmand—no

wonder it eats so much; in twelve hours it ate the weight of its own body; as if a man should in the same time demolish thirty four-pound loaves of bread!

But lest some matter-of-fact reader should consider this formation of a case at the edge of a leaf as a mere routine of instinct, let us see how Reaumur tested the resources of one of the same *Limosipennella.*

He did as I have done, turned one out to make a new case, but when the excavation was complete he cut off the teeth of the leaf. The two membranes flew apart, and the little larva seemed to be surprised and troubled; after a little hesitation apparently it saw the remedy, turned itself about, and threw a few threads from side to side, pulled them close and joined the rent. Then, as if considering that a like misfortune might happen again, before proceeding in the work of mining necessary for a full-sized case, it darkened the interior of the mine with a regular silken tube, which it left to continue and mine in a curve directly down the leaf and across the fibres. Now and then it returned to the tube, and lengthened and strengthened that; yet with strange forethought the case was not woven throughout—not at all; one side was merely tacked together and spaces left by which the larva could put out its head and cut the leaf between the fibres which now supported the case (fig. 8). Yet somehow perceiving that from the cutting away of the edge the natural curve was destroyed, the larva actually changed the aperture from one end to the opposite, in order to obtain the proper and convenient shape. At last, after two days' hard work, the tent was finished, and the thoughtful, patient little architect went on its way towards the development and perfection of its being.

The *Coleophora Vitella,* whose case is figured (2), may be found as early as April, having begun its case from the leaf of *Vaccinium vitis idœa* (cranberry) in the autumn, and up to the end of the month the case is being continually enlarged with pieces of the mined leaf, giving it a wrinkled appearance, and being paler near the mouth as fresh bits are added, and the case becomes pistol-shaped. The moth comes out at the end of June, and is abundant near Manchester.

Coleophora laricella (Fig. 4 A).—Very small is this pretty little tentmaker, feeding on the tenderest shoots of the larch in early spring time. It was hatched in the autumn, and mining a slender leaf it cut it off and hoisted it as a tent for its shelter and defence, remaining asleep in it all the winter, and with the first warmth of April, and with the cuckoo's note, awakening to feed on the under side of the fresh green leaves. The mine is very transparent, and the proceedings of the caterpillar easily observed. The moth is all one colour, a light brown

with silky grey under-wings. This is widely distributed at Guildford, Manchester, York, Scotland.

Coleophora juncicolella.—Lying on the heathy heights of Dover, watching the blue bright channel sea dancing the fleet of little fishing boats, and heaving the great ships to and fro, nestling for shelter in the tufts of Erica and Calluna, I idly wondered what those withered tips might be that topped the living stem. From the wide expanse of ocean and troubled thoughts within, the tent of the little Heath Coleophora turned eye and mind to ponder on the cunning work of this small architect. Who teaches it to pluck the little leaves, and count them seven or nine, nor more nor less, and weave them into this pretty case (fig. 5)? Some are withered and reddish-brown or yellow, and the lower ones are green, so making a parti-coloured tent, from which by and by a small grey-winged moth shall rise, and flit into the heath-bells for honey-drops and repose.

Coleophora Muripennella. (Fig. 6 A.)—Here is another surprise, picking the brown heads of Luzula in June, the seed vessels are all alive. Look closely; take a pocket lens; a little black head peeps out of a seed, and we find the larva has banqueted on the substance within, ensconced itself in the husk, and marched off to empty another seed, and so feed away until the long pupa sleep comes on, and April with its primroses and anemones brings also young Luzulas, whereon the delicately-striped brown moth will lay its eggs and finish the task of its life.

They are found, these curious cases, near London, Lewes, Worthing, York, Scarborough, Scotland, and the moth is abundant from April to June.

Coleophora Curricepennella. (Fig. 7.)—This pretty striped moth is more abundant abroad than in England, yet is found near London and Wimbledon in May and June, producing a larva which weaves a case entirely of silk, quite black, and with four projections, diminishing towards the mouth, and one row forming a right angle with another row. It eats the leaf so delicately that the parenchyma is removed, and the perfect network of fine veins is left unbroken.

Coleophora lineola. (Fig. 9.)—It is worth while having a good hunt for this tentmaker on the under side of *Ballota nigra* (black horehound), or *Lamium purpurea* (purple dead nettle), and if you see some whity-brown glassy-looking blotches in September on these leaves, look *under* the leaf, you will most likely find quite a little company of them perambulating a single leaf. By all means place one of these tents under the binocular; the silvery hairs upon the dark cuticle, and the fresh bit probably added to the first part of the tent, will delight the observer. And perhaps another is still more beautiful, the tent-maker

found on *Viper's buglos*, with its jointed hairs and thin crystal bulbs glistening like jewels on the dark green case. This is the *Coleophora Onosmella*, and found on chalky districts in the south of England, at Sandown, in the Isle of Wight, plentiful; and also at Dover.

Coleophora discordella. (Fig. 10.)—On grassy banks where the *Lotus corniculatus* grows, here we shall find this ingenious little workman very busy. Piece after piece he adds to his tent. Some brown, some yellowish, or nearly white, and it curves over like a reversed cornucopia. This larva feeds in August, and a silvery-striped pretty moth comes forth in June, for, like most of these case-bearers, it has a long larva-life of nearly nine months, hybernating in the cold winter, and recommencing active life in the spring.

Space allowed not of more drawings, but these will suffice to arouse attention, and I will add a list of plants on which to look for various species of tent-makers. Very likely this will lead not only to much personal pleasure, but to real advance in science, for the known species doubtless fall far short of the unknown, and the roads and lanes of England have many a footmark of Divine wisdom and goodness that may be found upon the track of our tiny *Coleophoræ*.

On the Rushes	*C. cæspititiella.*
On Silene inflata	*C. inflata.*
On Furze buds	*C. albicosta.*
On Knapweed.	*C. conspicuella.*
On Stellaria Holastea . . .	*C. solitariella.*
On the Sallow.	*C. viminetella.*
On Wormwood	*C. ditella.*
On Cistus	*C. ochrea.*

References to Plate.—Fig. 1. Coleophora chalcogrammella. 1·a. Larva-tent feeding on Cerastium arvense. 2. Tent of Coleophora Vitella. 3. Larva of Coleophora. 4. Shoots of larch with larva of C. laricella. 4 a. The tent of C. laricella magnified. 5. Tent of C. juncicolella on heath. 5 a. The same magnified. 6. Tent of Coleophora Muripennella. 6 a. The same magnified. 7. Coleophora Curricepennella. 7 a. The tent of the same magnified. 8. Elm leaf with tents of Coleophora Limosipennella. 8 a. A tent just cut from the leaf. 8 b. The larva walking off with its tent. 9. The tent of Coleophora lineola. 10. The tent of Coleophora discordella.

A VISIT TO LLANDUDNO.

BY HENRY J. SLACK, F.G.S.,
Member of the Microscopical Society of London.

A GLANCE at Professor Ramsay's excellent geological map of England and Wales will show a conspicuous and irregular mass of limestone, belonging to the carboniferous series, considerably to the left of the estuary of the Dee, and to the right of the Menai Straits. This is the Great Orme's Head, a magnificent promontory, protected through the hardness of its material from being washed away by the long-continued beating of the waves, which have hollowed out a huge gap in that portion of the British coast. Properly speaking the "Head" is the termination of the mass, the rest being locally known as the "Llandudno Mountain," beneath whose shade a smartly-built watering-place has rapidly sprung up, much frequented by Liverpool families, and catching an occasional Londoner to vary the scene. The Great Orme's Head is the attractive feature to the ordinary visitor. All round its sea-beat wall a pathway has been cut, beginning a few feet above the high-tide level, winding from east to west, ascending many hundred feet, and presenting at every turn a grand view of distant coasts, and wide-spread waters, studded with many a sail. Looking eastward, the eye roams beyond the Little Orme's Head, the other barrier of the little bay, catches the flat washy land of the two remarkable estuaries of the Mersey and the Dee; and rests, if the weather permits, on the shores of the West Riding of York. As the path winds, huge irregular masses of rock overhang the way; far down below seethe the white surge and foam, and presently, in a grassy slope, is seen the little church of St. Tudno, who must have been of a very ascetic way of thinking to have resorted to so wild a region, and one so remote from the society of his fellow-men. The path again ascends, and twists; Lancashire and Yorkshire are lost, and Anglesey comes more and more into view, with its outpost of Puffin's Island, in which multitudes of sea birds are said to breed. As the headland is rounded, the splendid cone of Penmaen-Mawr rises across the estuary of the Conway river; and when a southern view is obtained, the mountains of Snowdonia mingle their summits with the clouds, and close the scene. Sun-set pours its red and yellow light gloriously over these varied outlines, and those who differ from Hood in the assertion that

> "A man that's fond precociously of stirring,
> Must be a spoon,"

speak with equal favour of the magnificence of the sun-rise.

Continuing the circumbendibus brings the pedestrian with his back to the sea and his face towards the mouldering towers of Conway Castle, once more to Llandudno, after a walk of more than five miles, and very near the spot at which his peregrinations commenced.

This is one way of enjoying the Llandudno mountain. Another is to climb up a steep road, and arrive at a miniature plateau some 600 or 700 feet above the sea level. In this journey, one or two copper mines, apparently not over productive, are passed; and at nearly the highest spot is a low building, maintained by the Liverpool Corporation as a look-out house, from whence ships destined for their city can be first descried, and the news telegraphed to the busy merchants on 'Change. Three telescopes, let into copper panes of the bow-window by a ball and socket joint, enable the observer to see in any direction without exposure to the weather; the telegraph machinery is under his thumb, scores of posts bear its wires down the hill, and then a few vibrations of the obliging needle tell the news on which the profit or loss of the shippers may depend. This *was* the state of things last September, but a few hundred feet lower, and less influenced by sea-fog, a lighthouse was rising among the rocks, and to that locality the look-out and telegraph business was about to be transferred.

At the time of my visit one part of the little plateau was like a formal garden of nature's own contriving, but preserving with its regularity that wildness which exerts a lasting charm. Hundreds of small, round, and flattened furze bushes—floral puddings, as they might be called—blazed with yellow bloom, and in the centre of each mass gleamed the rich purple of the heather-bell. In less fertile spots the hard whitened rock lay in flat strips of varying breadth, and in the clefts flourished the dark, stiff foliage of the rue-leaved spleenwort, sometimes accompanied by flowering plants. Occasionally a little hollow made a water pool, with leathery green leaves growing in it, and forming an abode for numbers of the common rotifer, which seemed as happy as at lower levels and in larger ponds.

A marine zoologist living at Llandudno can do a good deal, as the magnificent aquarium formed by Mr. Drabble, and described in a former number, will amply prove, and as may be seen from the subjoined list which he has enabled me to give :*—

It is not, however, a very good place for the casual visitor,

ZOOPHYTES.

* Caryne pusilla.	Tabularia larynx.
" sessilis.	Halecium halecinum.
Tubularia indivisa.	Sertularia polyzonias.

as the most accessible beach—that of the Conway estuary—is rather poor in specimens, and the other one—opposite the Parade and below the Baths—does not yield much, except at low spring tides. On such occasions you must watch the time, rush down at the right moment, search in nooks and crannies with impetuous haste, chisel and hammer at the rocks with speculative rapidity, never mind if the waves turn round upon you before your labours are concluded, provided that they leave a possibility of retreat, and you will then return duly splashed and wetted, with bottles and a basket full of treasures which will keep your hands and microscope employed for many a day.

Many parts of the Devonshire and Dorsetshire coasts are much more practicable for ladies, who ought to be made upon mermaid principles, with their lower halves specially adapted to the briny abode of the tritons and the nymphs, in order to enjoy the slopping and puddling manœuvres which the Llandudno collector has to go through. The process is, however, well worth the trouble, as my first haul will show. Here was a reddish-yellow gristly and slimy lump, ugly enough before being placed in a basin of water, at his ease. Then out came the elegant bunch of gill plumes from his back, the pretty tentacles from his head, and the fine sea-slug, the *Doris tuber-*

Sertularia fallax.	Plumularia falcata.
,, abietina.	,, cristata.
,, filicula.	,, setacea.
,, operculata.	Laomedea geniculata.
,, argentea.	,, gelatinosa.
Sertulariacupressina.	Campanularia dumosa.
,, pumila.	,, volubilis.
,, rugosa.	Alcyonium digitatum.
Antennularia antennina.	

ANEMONES.

Sagartia viduata.	Actinoloba dianthus.
,, troglodytes.	Actinia mesembryanthemum.
,, aurora.	Bunodes crassicornis.
,, venusta.	Edwarsia carnea.
,, miniata.	Peachia hastata.
,, coccinea.	etc., etc.

POLYZOA.

Tubulipora.	Membranipora pilosa.
Crisia eburnea.	Lepralia (various).
,, denticulata.	Cellipora.
Crisidia cornuta.	Alcyonidium gelatinosum.
Cellularia.	,, hirsutum.
Scrupocellaria.	Cycloum papillosum.
Canda reptans.	Valkeria.
Gemellaria loricata.	Bowerbankia.
Bicellaria ciliata.	Pedicellina Belgica.
Bugula avicularia.	,, echinata.
Flustra foliacea.	etc., etc.
Membranipora membranacea.	

culata, rejoiced the eye. He is no rarity, but, like most of his family, beautiful when displayed, and great is the wonder of those who have no acquaintance with this kind of creature to find its gills, or water-lungs, converted into decorations as fine as any ostrich plume. Two other items look even more unpromising at first sight than our friend the slug; they are dirty leathery tubes, caught up from little hollows at the bottom of the rocks. They, or rather their inmates, are now happy in a washhand basin, which, for a time, will do as well for them as Llandudno Bay. From each tube comes forth an exquisitely painted thing, something between a fan and a flower. Here again are specimens of ornamental gills. Through each plume the fluids to be aerated take their course. While all is quiet, the living fan, or flower, expands its rays; but if danger approaches, in goes the wondrous apparatus, and only the dingy tube remains in view. Mr. Gosse has described how these worms (*Sabella*)* make their tubes, and they are so much at their ease in Mr. Drabble's aquarium, that they will replace the plumes which some habit of their nature, or temporary disease, causes them to shed.

It is a very common characteristic of the sea-beauties to be mere lumps of ugliness when not at home. The two instances given will illustrate this fact, but here are morsels of dirty gristle, yellowish and white, more or less cleft into lobes and finger-like projections. Nothing could seem further removed from the ideal than such unpleasant prosy dabs. They were torn off the sides of rocks, which only low tides uncover, hid among the hanging tresses of the Bladder-weed (*Fucus vesiculosus*), and only discoverable by active search. These, too, the friendly basin holds, and after they have had time to get over the flurry incidental to their capture, from every dent and pore out come hundreds of polyps, clear as crystal, each enjoying its individual life, and also its portion of the social or collective life of the entire mass, which is named "Mermaid's Glove," "Dead Men's Fingers," or *Alcyonia digitata*.

Small lumps of honey-combed rock, struck off with hammer and chisel, are among the captures of the day. They were selected because certain little red spots, visible till disturbed, suggested a probability of acquiring the not very common and very pretty anemone, the *Edwardsia carnea*, which Mr. Gosse figures and describes in his admirable work. When they think all is safe, they come out of their little caves; when alarmed, they retreat, and no one unacquainted with their habits would suspect their existence in the deserted-looking rock.

Other classes of creatures have helped to fill the bottles and the basket, such as polyzoa, and polyps very different

* See INTELLECTUAL OBSERVER, March, 1863, p. 77.

from the Alcyonia in their mode of fashioning their homes. The Llandudno beach yields a good supply of Bugula, a branching polyzoon like a tiny shrub, having its groups of cells so arranged as to produce a pattern something like what would result from putting a series of funnels one in the other, with their spouts pressed close to the sides of the mouths, in which they were immersed. This is not an *exact* description, but near enough to help a beginner in recognizing this curious thing. These Bugulæ are good specimens of the polyzoa to exhibit the bird's-head processes, which occur in many genera, and still puzzle naturalists to explain their use. They are attached to the corners of cells; often look, as in this case, like vultures' heads, and nod and snap their beaks with pertinacious efforts, that sometimes catch a creature that may be swimming by. Mr. Gosse considers their function is to hold such objects, in order that in their decay they may attract other creatures which the ciliary currents, kept up by the tentacles of the polyzoon, may draw into its ravenous mouth. The specimens of Bugula which I collected at Llandudno in September, did not, in any case in which I watched them, open and snap their vulture heads, which either nodded like so many mandarins, or remained perfectly still. I do not know whether the animals were sickly, or whether the activity of their heads varies with the season or temperature to which they are exposed. The heads are pretty objects under a quarter-inch or fifth objective, and much more brittle than the material of which the cells are composed, so much so that, when dried, a slight pressure of the live-box crushes them like glass.

I cannot describe each species, or genus, obtained between the tide-marks, but may mention that *Crisia, Valkeria, Lepralia, Membranipora, Sertularia, Laomedea,* etc., etc., were amongst the lot; but having to make a selection from my notes, I will first say a few words on the microscopic examination of such an object as *Membranipora pilosa*, a very common polyp covering sea-weeds with a crust, and often following their shape; and then make, for the nonce, the odd-looking and oddly-behaved *Pedicellaria echinata* do duty for the tribe Polyzoa, to which he belongs. Turning to Johnstone's *Zoophytes* we find the Membranipora described as follows—"Polypodium encrusting, membrane calcareous, spreading irregularly, formed of a single layer of alternating approximated cells; cells oval, horizontal, membraneous, the aperture patulous, with a hard calcareous rim." *M. pilosa* is described as having "aperture of the cell with one long hair and several spinous denticles." Now this and many similar objects are too small to be seen properly with a very low power; and if a higher one, say fifty or sixty linear, is employed, certain parts are quite out of the focus when

others are in. The only way to proceed with such things is to get a good general notion with a pocket lens, or three-inch glass first, and then take the higher power, remembering that no *one* view can possibly give a correct idea of the whole. The long spines of the *M. pilosa,* for example, may be optically reduced to a little boss at their base, through all the rest being out of focus and not seen. The observer must gradually focus up and down, carrying in his eye what the glass at each movement fails to reveal, and if this is carefully done a good many times, a right conception of the object will be obtained.

Returning from this digression to the *Pedicellina echinata,* I will now introduce the reader to a curious polyzoon not uncommon, but interesting from its departure from the more usual patterns of the class to which he belongs.

The *Pedicellinæ* may be rudely compared to the short flexible sticks with knobbed ends, called "life-preservers," and the present species (*echinata*) has spines down the aforesaid stick. Most of the polyzoa* have long tentacles, which are always stiffer than those of the polyps, and furnished with cilia that are readily seen. Were we only acquainted with the long tentacled kinds, we might imagine that short tentacles would not suffice to do enough food-catching to keep one alive; and this may be the case in situations where their prey is scarce; but there are places in which polyps can live whose tentacles, as in the Corynæ, are reduced to mere knobs, and in which a correspondingly stunted polyzoon gets on very well. I do not know enough to assert that this food question settles the short-tentacled difficulty, but the explanation is probable, and we can easily conceive that long-armed polyps and polyzoa might flourish where shorter armed species would starve.

Some of my *Pedicellinæ* pursed up their mouths by keeping their tentacles in, others expanded themselves, as shown in the sketch made by my wife, while others were content with an intermediate state. They were the most lively I ever caught, being in constant motion, thumping about in all directions, sometimes coming down right and left with hammer-like blows at nothing, at others executing a spiral manœuvre, and giving a corkscrew wriggle to their stout flexible stems, which were ornamented with occasional spines. They were far from nervous, and did not mind coming into contact with other bodies, and must have been troublesome neighbours to the more timid and quietly disposed inhabitants of the various cells in whose vicinity they lived and banged about.

There was frequent motion in their tentacles, and for a moment one set were fully spread out; but after watching them

* See my paper, INTELLECTUAL OBSERVER, Vol. II., p. 271, on the "Statoblasts of a Plumatella," for some general remarks on these creatures.

for hours I could trace no co-ordination between the movements of the stems and those of the tentacles. They were not directed to a common object of catching food, and if the *Pedicellinæ*, like other polyzoa, possess a "colonial nervous system," they have no brain capable of directing their whole mechanism to an intelligently devised end.

PEDICELLINA ECHINATA.
(c, c, c, Ciliary Action.)

The whole class of polyzoa possess, so far as I have observed them, very restless stomachs, and in the *Pedicellina* the particles of food were not suffered to be a moment at rest, but were spun round and round by the constant action of the cilia with which the digestive tube is lined. In the pursed-up individual to the left of the engraving, the dark mass appeared to consist of the remains of a feast, ready to be turned

out of doors, while the lighter mass below it, still under process of digestion, performed the circumtwistatory movement imparted to a leg of mutton by a roasting-jack. In some other Polyzoa, as the Plumatella, the food is tossed backwards and forwards up and down the digestive tube.

In the sketch some of the stalks are without heads, or more properly *bodies*, and on this subject Johnston observes* that, "like the hydroid Tubularinæ, the life of the body is of shorter duration than that of the stalks, the former fading or falling off, when a new one is reproduced in its place." He likewise cites Professor Reid to the following effect:—"A few days before this (the falling off of the body) takes place, the tentacula are permanently bent inwards, and the membrane surrounding their lower parts remains contracted, so as to completely, or nearly completely, cover the upper surface of the body, presenting, in fact, the appearance which the animal temporarily assumes when disturbed. The body then becomes more opaque, and at last falls off. When this has taken place the stalk retains its property of alternately contracting and relaxing its different surfaces at intervals, upon which its movements depend. After the lapse of a few days the top of the stalk enlarges, and a minute head presents itself, in which the different parts of the body are developed." This is an interesting fact when it is considered that the body contains the mouth, stomach, and other important organs, and also the nervous ganglion which performs the functions of a restricted brain. It is an instance of the power of the colonial life which animates every member of a polyzoan group in addition to what we may term his individual life, and is evidently a process of the same character as that which forms the original offshoots from the parent stem. Inside the mouth cavity, and below the tentacles, ciliary action may be observed, and favourable specimens display the circular band of muscles running round the margin of the cup, whose function is to pull it together.

Professor Allman discovered an arrangement of the tentacular disk which approaches these creatures to the Hippocrepian Polyzoa, that is to those in which the tentacles are arranged not in a circular, but in a horse-shoe group. Three species may be found on our coasts: the *P. echinata,* just described, with spines on its stalks; the *P. gracilis,* which has stalks smooth, thin, and long; and the *P. Belgica,* with smooth stalks inflated about the middle. The stalks rise from a creeping shoot, and the creatures are commonly found parasitic on corallines and sea-weeds, between tide marks, but especially near low-water mark. The species mentioned above vary in

* *A History of British Zoophytes,* by George Johnston, M.D., LL.D. Second edition, p. 384.

the number of their tentacles. *P. Belgica* has twelve tentacles, *gracilis* and *echinata* about twenty. Some of my specimens of *P. echinata* had eighteen.

In Mr. Gosse's *Devonshire Coast* he mentions an instance of a colony of *P. Belgica* growing as parasites upon the tail of a Syrinx, a wandering animal of vermicular shape belonging to the Echinodermata, and, as might have been supposed, an unfit site on which to found a colony of Polyzoa.

Many other objects of interest rewarded a little pains taken at Llandudno, but I will only allude to one of them, the *Perophora,* just for the sake of mentioning a rapid change in transparency which a short period produced in this interesting mollusk, without its showing any other symptom of bad health. One afternoon Mr. Drabble brought in a group of *Perophora* to show the beautiful ciliary action of its internal gills, which he had been admiring under his own microscope shortly before. On trying it with mine our success was very moderate, and no mode of illumination would make it sufficiently clear. For experiment sake he fetched his own instrument, but the result was the same, the explanation being that the outer skin of the animal had contracted, or undergone some other change, and its translucency was impaired.

Some of my readers may find themselves at Llandudno, and the preceding remarks may help them to collect objects; but most that I have said will apply to other sea-side places, and none can be found in which nothing of interest for the microscopic naturalist exists. My Welsh trip left many pleasing recollections, but there is a peculiar charm in marine zoology, and while the outlines of hills and mountains often rise in my view, I see with equal clearness of remembrance the motions of the *Pedicellinæ,* or the brilliant lightning sparks emitted by irritated colonies of *Sertularia* newly dredged from their homes at the bottom of the bay.

ON CAMPHOR PULSATIONS.

BY CHARLES TOMLINSON,

Lecturer on Physical Science, King's College School, London.

[WE have much pleasure in publishing the following interesting letter from Mr. Tomlinson, who is quite right in stating that the article in our May number to which he refers did not detail all the precautions necessary for the successful performance of the more delicate experiments. Our object was rather to call attention to his very good and accessible book than to supply a substitute for it. We are glad to hear that the further investigation of the "Storm Glass" occupies his attention.]

In the INTELLECTUAL OBSERVER for May last you notice briefly a few experiments from my small volume recently published, entitled *Experimental Essays;* so briefly, indeed, that should your readers endeavour to repeat them they may fail of success through not taking all the precautions which I have detailed in my book. For example, the experiment for exhibiting the camphor currents is one that requires great care, and several favourable conditions to make it succeed. In the *first* place, the vessel must be quite clean; *secondly,* the water must be quite clean,—it need not be distilled; *thirdly,* the camphor must be cut into the form of a stick, or a three or four-sided prism, and be mounted in forceps, as shown in the engravings on page 38 of my book; *fourthly,* the surface of the water must be very faintly dusted with lycopodium powder, which is best done by tying a small quantity of it up in a muslin bag, and gently shaking it over the surface; *fifthly,* the day must be fine and dry. If all these conditions be observed the experiment will succeed. As soon as the camphor is lowered into the water a powerful repulsion of the lycopodium powder takes place, occasioned by the formation of a camphor film, from which lines of solution will stream out, and, being reflected symmetrically by the side of the vessel, will throw the lycopodium powder into pairs of revolving wheels, and the action will continue with greater or less vigour so long as the camphor continues to be immersed, provided the air be sufficiently dry to get rid of the film by evaporation. In the course of some hours, depending on the size of the camphor stick, the camphor will be cut across at the surface of the water (as in Venturi's experiment, described in my first essay), and the lower portion thus becoming detached will rotate about the surface of the water and destroy the symmetry of the lycopodium wheels. On removing this piece, and lowering the stick so as to dip just below the surface of the water, the currents will set in afresh, and a new incision be made in the camphor. In this way I have kept up these currents for fifty or sixty hours.

The vessel selected for the above experiment was a conical foot glass, four inches in diameter at the mouth. I have lately had occasion to show the experiment in a very shallow vessel with a flat bottom, and have obtained some additional results, which may be interesting to your readers. Two vessels were employed, one a glass saucer, used for holding a glass flower pot; it is five inches in diameter, and slightly raised at the bottom. The other a flat dessert dish of uncut glass, 6½ inches in diameter. The phenomena are best seen in glass vessels, but a dinner or dessert plate will answer the purpose. The glass saucer was made quite clean, two ounces of water were poured into it, and a stick of camphor, 1½ inch long, and about ¼ inch square, with a square base, mounted in forceps, was brought down so as to touch the bottom in the centre of the slightly convex swelling. No sooner does the camphor touch the water than a series of vibrations sets in, agitating the whole surface of the water with rapid pulsations, so rapid, indeed, that it is scarcely possible to count them. I have, however, made out as many as 260 per minute.* In this small quantity of water solution takes place rapidly, and the water becomes saturated; hence the pulsations gradually diminish to 60 or 80 beats per minute, when solution and evaporation may be considered as pretty well balancing each other. I have even known the pulsations to sink down to 8 or 10 per minute, and to subside altogether when the air became damp from wet weather. On changing. the water the pulsations will set in again, but not with the maximum rapidity, unless in a dry air.

There is one condition connected with the complete success of this experiment which I was some time in discovering. It is this. The stick of camphor must be cut in the direction of the grain or cleavage of the camphor, but not across it or obliquely to it. On holding a piece of camphor up to the light it will soon be seen in what direction the cut is to be made, and when the piece has been nicely trimmed and mounted in its forceps, and brought down so as to touch the bottom of the vessel, the action appears to be this:—The water rises by capillary attraction some way up the camphor, and detaches a portion of its substance, which is then spread out in the form of a film over the surface of the water by the attraction of adhesion, and is there disposed of by solution and evaporation, after the manner of essential oils. As the film is being detached, it repels the water from the camphor, and produces a depression of surface all round the stick; the water recovers itself by a bound, capillarity again comes into play, another film is detached, and matters proceed as before; the result being a series

* These rapid pulsations are best seen on the larger surface of the water in the dessert dish.

of pulsations or waves, which rise up so that their crest may be one, two, or three-tenths of an inch above the general surface of the water. These variations in height are marked by a series of curved grooves or ripple lines on the sides of the camphor, which gradually changes its dull translucent appearance for a bright transparent one, showing that the water has penetrated it. In the meantime an incision is made in the camphor, which goes on increasing as successive films are detached, until at last the stick is cut through, and the submerged piece commences a series of gyrations on its own account.

If lycopodium powder be faintly dusted over the surface, the camphor currents and pulsations may on a fine day be seen together. If two sticks of camphor be lowered into the same surface of water, the interference of the currents will be shown by the motions of the powder.

As in the case of small fragments of camphor rotating rapidly on the surface of water, the rotations are stopped if the water be touched with a fatty oil, so these pulsations are immediately arrested if the water be touched with a drop of any substance which spreads into a film, and arrests evaporation. The point of a pin dipped into olive oil and brought into contact with the water, at once arrested the lycopodium currents, a second contact stopped the pulsations. So also, if a body be added to the water that satisfies its adhesion, or, in other words, stops the solution, the pulsations are arrested. Thus a drop of oil of camphor will stop the pulsation by depriving the water of the power of dissolving camphor; a drop of olive oil will stop the pulsations by preventing the water from evaporating; but a drop of oil of bitter almonds, which speedily evaporates, will allow the pulsations to go on again very soon after it has been added. Turpentine, oil of cajeput, kreosote, etc., stop the pulsations; but ether, alcohol, benzole, naphtha, bisulphide of carbon, caustic potash, and sal-ammoniac, allow them to go on freely. A bit of sponge tied to the end of a glass rod, if dipped in ether and held near the camphor, will hold up the wave of water against the camphor for some time. A drop of benzole does not stop the pulsations, but it makes them less rapid. The pulsations will go on in a solution of caustic potash and in one of sal-ammoniac, and I have no doubt that the action of acids, etc., on rotating camphor as described in my first "Experimental Essay," will have a similar action on the camphor pulsations.

In your notice of my book you say that I do "not seem by any means to have exhausted the curious subject of the Storm Glass." I had reserved this subject for a separate essay, a copy of which I hope to have the pleasure of sending you shortly.

With respect to the motion of camphor towards the light

you do not seem to have apprehended me fully, or I may not have expressed myself clearly. My theory is that light has nothing to do with the deposit of camphor, of vapours, or of crystals of saline solutions on the most illuminated side of the glass vessels that contain them, but that such deposits are formed by condensation on the coldest side of the vessel, which may or may not be the most illuminated side. If a number of bottles containing a little camphor, naphthaline, iodine, water, turpentine, etc., be placed in the window, the deposits will be formed generally on the side nearest the light, because that side is generally the coldest; but if the sun be shining on the window, the side nearest the light will be the hottest, and the deposit will go to the back of the bottle, or to the coldest side. If the bottle be equally heated in every part, and equally cooled, no deposit will be formed except at the bottom of the vessel, unless the cooling be sufficiently rapid and great to condense the elastic vapour as it subsides. We shall then have a deposit equally all round the glass, and this is the more likely to happen with a thin one, because glass being a bad conductor of heat, a thick narrow glass is not so likely to cool unequally; it does not, in fact, present a cold side and a warmer side, unless under favourable circumstances. For instance, a thick barometer tube containing a charge of camphor was left in one corner of a warm room, it was afterwards exposed to the cold of winter, and when next examined it was found to have a deposit equally all round. It will, of course, be understood that under all ordinary circumstances a bottle containing camphor, etc., is filled with the vapour of that substance at all ordinary temperatures. A certain depression of temperature is required to cause a deposit, as in the case of dew, and unless the temperature be sufficiently depressed there will be no deposit. In vacuum, the camphor deposit may be formed in a few minutes, as in Dr. Draper's experiments, and it was to get rid of the cumbersome machinery of air-pump, and air-pump receivers, that I made use of the more sensitive crude camphor, which forms a good deposit if a little of it be placed at the bottom of an ordinary corked vial. So sensitive is this vapour of crude camphor that it will revive marks, and small impurities in the bottle, the presence of which was not suspected. The minute invisible filaments left by the duster used in wiping out the bottle, become visible in a few minutes after the bottle has received its charge of crude camphor, and exposed in the window in consequence of becoming coated with that substance condensed upon them.

King's College, London,
15th June, 1863.

NOTES ON THE MOLE.

BY THE REV. J. G. WOOD, M.A., F.L.S.

A FEW days ago, a deputation of young friends brought me a fine specimen of the common mole, which they had captured in Belvedere Park. The creature had evidently contrived to get upon a patch of hard ground—the gravel comes to the surface in this locality—and before it could make its way below the stony ground, it was pounced upon and secured. The little captive was not in the least injured, and I transferred him to a rather large box, which I placed in the garden.

He ran about the box with great agility, thrusting his long and flexible snout into every crevice, and paying especial attention to the corners, in each of which he scratched perseveringly for some minutes. Seeming at last to make up his mind that he could not escape, he screwed himself into a corner, poked his muzzle into the darkest recess, and remained motionless as if dead. I then quietly introduced a few spadefulls of earth into the box, and scattered a little of the fresh soil under the creature's nostrils. New life seemed to be infused into the mole by the contact of the earth, and, Antæus-like, he inspired fresh vigour from the touch of mother Tellus.

The mole traversed the box with wonderful rapidity, pushing his way through the loose soil, entering and re-entering the heap, and in a few moments had scattered the earth tolerably evenly over the box. Every now and then the whole skin gave a quick convulsive shake, which had the effect of throwing the loose earth from the fur. This peculiar shake, or twitch, was really a curious sight. At one moment the mole was grubbing away, hardly to be distinguished from the surrounding soil, so completely was the fur covered with the dusty particles; suddenly a spasmodic shudder passed through the body, and in a moment the moving dust-heap had vanished, and in its place was manifest the soft, velvet coat of the mole.

The creature was unremitting in his attempts to escape from the box. After satisfying himself that he really could not burrow through a deal-board—a lesson which was not learned until after many attempts and as many failures—the creature tried to scramble over the sides, and stood perseveringly on his hind legs, scraping pertinaciously at the smooth wood, and ever and anon slipping sideways, and coming on his fore-feet.

The mobility of the long snout is really astonishing. The animal moves quickly about with an uncertain kind of gait, now to one side and now to the other, popping the nose here and there so rapidly that the eye can hardly follow its movements.

The senses of sight and smell seem to be practically obso-

lete. I placed a worm upon the track of the mole, and though his nose came within the tenth of an inch of the worm, he did not seem to be aware of the presence of his prey. I tried this experiment eight or nine times in succession, and always with the same result; but if the nose or either foot happened to come in contact with the annelid, the mole flew round in a moment, flung himself upon the prey, shook the worm backwards and forwards with his paws, passed his snout rapidly over it, bit it here and there, and scratched it about until he got one end of it into his mouth; either end answered his purpose equally well.

He then began to eat it in a most voracious manner, arching his back, sinking his head between his shoulders, keeping his fore-feet close on either side of his mouth, and using them with great dexterity, just as a Chinese uses his chopsticks, cramming the writhing annelid into his jaws as fast as it was eaten. The crunching sound of his teeth making their way through the tough skin of the worm was audible at a distance of two yards, and a sort of fury seemed to actuate the animal; it ate as if savage with hunger, and as fast as I could supply it with worms, so fast did it devour them.

One worm was of huge dimensions, and the mole could make nothing of it for a long time. He trampled over it many times, passing the worm underneath his body from his fore to his hind feet in a very peculiar manner, scuffling it, as it were, backwards and forwards. He bit it in twenty places, left it, came back again, got each end successively into his mouth, and rejected them both, and altogether behaved in a manner that could not have been pleasant to the worm. All this time the mole was full of excitement and fiery activity.

At last, he seized the worm about an inch from the head, held it fast with his jaws, and with his feet pulled it asunder. He then dropped the severed piece, searched for its head, found it, and crunched it up. He then scrabbled about until he came upon the rest of the worm, and pouncing upon it, like a cat on a mouse, he pulled off another piece, ate it, and so proceeded until he had finished the worm in detachments. Whenever he swallowed the last morsel of the worm, he used to potter about the same spot for some little time, trying it over and over with his nose, and ever and anon returning to it. I fancy that this precaution is taken for the purpose of securing any fragments of the worm which may have been bitten off, worms being sometimes very brittle.

The creature had now disposed of six worms, some of moderate size, and one three times as long as the mole itself. He seemed as hungry as ever, so I set to work and dug up a fresh supply. I could still hear the animal scraping about the box,

and my cat heard the noise also, and became very uneasy, trying to lift up the lid of the box, and catch the inhabitant.

After reducing pussy to reason, and making him understand that moles were not mice, I proceeded to give the animal a second supply of worms. He was just as furious about them as he had been with the former batch, and ate them as rapidly as before; inclusive of the time occupied in digging up the worms, fourteen were eaten in thirteen minutes. The second batch consisted of ten worms, all rather large, and these were as quickly devoured.

Wishing to know whether he would eat the common Julus millipede, I put a fine one on his track. As soon as he felt its writhing form touch his feet, he pounced on it as he had done with the worms, and scrambled it under his nose. As soon, however, as the sensitive snout touched the millipede, the mole threw up his head, and with one of his fore-paws chucked—there is no other word that expresses the action—the julus on one side, flinging it about two or three inches away.

I tried this experiment several times, and always found that the mole flung the julus away in the same manner. There was something inexpressibly ludicrous in the change of manner that came over the animal whenever he found that he had seized a julus instead of a worm, and the contemptuous air with which the millipede was tossed aside was most absurd.

About 8 P.M. I resumed the fork and spade for the purpose of procuring the mole's supper. Having heard from popular report that a twelve hours' fast would kill a mole, I determined to afford the creature a bountiful supply of food late in the evening, and then to give him his breakfast about 5.30 or 6 A.M. next morning.

So I dug perseveringly until I had captured a large handful of worms, and about 9 P.M. I put them into the box. As the mole went backwards and forwards, he happened to touch one of the worms, and immediately flew at it. While trying to get its head into his mouth, he came upon the whole mass of worms, and flung himself upon them in a perfect delirium of excitement. He kicked them backwards and forwards under his body, he trampled over them, he pulled them about, and seemed so overjoyed at his treasure that he could not settle upon any one individual. At last, however, he caught one of the worms, and began to crunch it, the rest uncoiling their many folds, making their escape in all directions, and burrowing into the loose mould.

Thinking that the animal was now well supplied for the night, some two dozen worms having been put into the box, I shut him up with an easy conscience.

Now, it so happened that on the following morning the rain

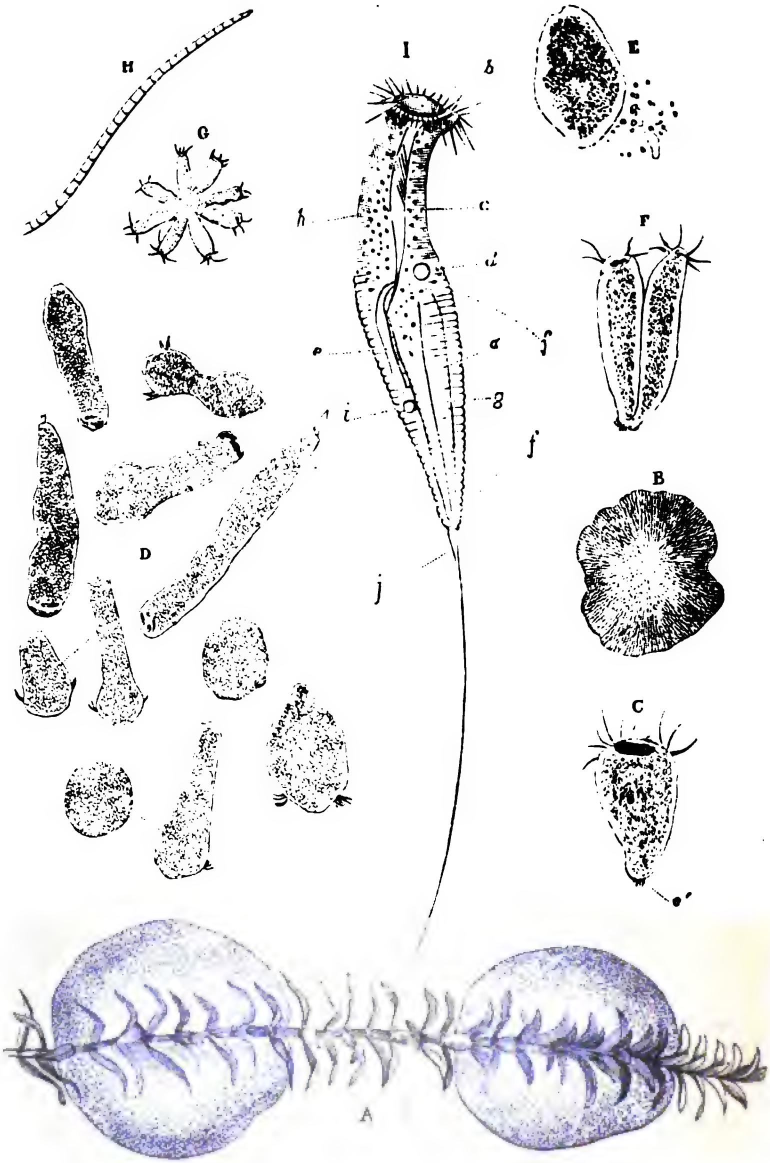
was falling, or rather being blown, in a perfect torrent. Hoping that every hour might bring some remission of the tempest, I waited until about 9 A.M., and then opened the box. Twelve hours had just elapsed since the mole had received his last supply of worms, and as he must have spent considerable time in hunting them about his box, I should think that at least another hour must have passed before the last worm was consumed. But, the mole was dead. He had not been dead very long; he was quite stiff, with one of his paws held out sideways, as if his last act had been to fling the julus away, and his nose, still flexible, was pressed upon the earth.

I much lamented his loss, but could not charge myself with neglect. I forgot to weigh the worms which he devoured, but as they would have filled my two hands held cupwise, I may infer that they weighed very little less than the animal who ate them. From the extreme voracity and restless movements of this creature, I can well comprehend the value of the mole to the agriculturist; firstly, as a subsoil-drainer, who works without wages, and, secondly, as the means appointed for keeping the prolific race of worms within due bounds.

Of course, the fur was filled with parasites, as is the case with all animals, and very tough parasites they were, refusing for a long time to succumb to the fumes of ammonia, and being only killed by a twelve hours' immersion in that potent vapour.

Being desirous of turning the dead animal to the best account, I determined to try my hand again at preserving the skin after Mr. Waterton's system. I have already tried a water-vole, and failed very completely, but hope that this time the defeat will be less conspicuous.

As the fur was slowly drying after its immersion, I was surprised to see that a decided reddish tint was perceptible upon its surface. Thinking that this effect might have been produced by the reflection from some coloured substance, I moved it to another window, but found that the colour was visible whenever the light fell obliquely upon the fur. The tint is exactly that of a copper teakettle just where the copper changes into red, and whenever the light falls diagonally upon the fur, a rich green gloss plays fitfully over the soft hairs. These effects were not visible before the fur was thoroughly washed, and even the gray-brown tints seemed to deepen notably after the cleansing process which precedes the skinning of quadrupeds intended to be mounted upon that system.



Ophrydium versatile.

[illegible] tapering [illegible]

[illegible] shaped [illegible] surface [illegible]

[illegible] with a [illegible] rotary disc. [illegible]

OPHRYDIUM VERSATILE.

BY REV. W. HOUGHTON, M.A., F.L.S.

(*With a Tinted Plate.*)

A FEW remarks on this extremely interesting form of infusorial life may be acceptable to the readers of this magazine, many of whom, it is probable, have never been fortunate enough to see these bright green balls to which Ehrenberg has given the name of *Ophrydium versatile.* I find immense numbers of these balls in the clear water of a canal near my house, and should be happy to send specimens to any microscopic readers of the INTELLECTUAL OBSERVER, who may be particularly anxious to make the acquaintance of our versatile friend, provided such requests do not come in overwhelming numbers. At first sight an observer would be inclined to refer these vividly green masses to the vegetable kingdom; indeed, some years ago, botanists did claim them for their own, and gave the production in question the appropriate name (so far as external form is concerned) of *Nostoc pruniforme*; but no apple or green-gage plum is worthy, in point of colour, to be compared with good specimens of *Ophrydium.*

In Pritchard's last edition of the *Infusoria* (p. 598) *Ophrydium* is arranged with the genera *Tintinnus, Vaginicola,* and *Cothurnia,* and forms with them the family *Ophrydina.* This is Ehrenberg's arrangement, which, however, is very unsatisfactory. Stein and Dugardin refer the four genera just named to the *Vorticellina* group; it is, I think, impossible to study the characters of the individuals which belong to those genera, and not feel convinced that their true affinities are with that family.

There is very great difference of opinion with regard to the classification of the infusoria, and the various systems which have been proposed must, as Mr. J. Reay Green observes, "be regarded as premature, since we know so little of the life history of these animals that it is by no means improbable that many apparently distinct species are nothing more than transitional conditions of more adult forms." We may, however, I think, refer *Ophrydium* to the *Vorticellina,* without being very far from the mark. Fig. A represents a couple of *Ophrydium* balls attached to a piece of *Anacharis alsinastrum.* So far as I am aware one species alone of *Ophrydium* has been described, viz., *O. versatile.* It is thus characterized in Pritchard's *Infusoria*:— "Body fusiform, tapering to a fine extremity from behind the middle, and anterior to it contracted into a cylindrical neck, supporting a funnel-shaped head, surmounted by an annular peristom, with a ciliated rotary disc. The mouth opens into a narrow

and long ciliated œsophagus. The contractile vesicle is seated near its end; the nucleus is long, narrow, and twisted. The external surface is thrown into close annular folds; and usually three longitudinal plaits extend from the posterior end as far as the middle of the body, which disappear when the body contracts. A subjacent cortical lamina is evident, and imbedded within this, numerous chlorophyll utricles, giving the animal a vivid green colour. When contracted, the body assumes the form of a long-necked flask, and even the nucleus shortens itself. In more complete contraction the figure becomes oval or globular. Fission is only longitudinal. When an *Ophrydium* quits its hold after fission, it swims away by means of a temporarily developed posterior wreath of cilia, just like a *Vorticella*. It is found encysted, and Stein believes in an acinetiform phase. Vividly green and associated in smooth and globular clusters or masses, which vary in size from a pea to a ball five inches in diameter; they are either free or attached. Ehrenberg states that in May, 1837, he saw hundreds of clusters as large as the fist, which, by the evolution of gas, were at intervals elevated to the surface, and driven by the wind to the edge of the water. In sea-water, also found by Brightwell, in fresh-water, and in a small turf pit, upon tendrils of roots of marsh plants, and the stalks of the white water-lily. Length of single animalcule stretched out, 1-120" to 1-90"."

From this description it appears that *Ophrydium versatile* is an inhabitant both of fresh and salt water. I have never seen it in salt water, but have met with it in canals and ponds. It may be found throughout the whole of the year, and I have even obtained large specimens from water which had been frozen over; but in March and April the specimens appear to be most abundant, and the most beautiful both in form and colour. Fig. I represents a single individual magnified about 400 diam.; the parts referred to in the description given above are clearly visible. The animalcules are imbedded in a nearly colourless (not "greenish," as Mr. Reay Green states) gelatinous substance; it is the animalcules themselves that give the green colour to the whole ball; they project their anterior extremities beyond the surface of the jelly-like mass, and are firmly attached to its substance by means of a very long non-contractile tail or peduncle, which breaks off from the body when the individuals take to a wandering mode of life. The gelatinous substance, which is homogeneous in nature, and not composed of numerous little cells as Ehrenberg has stated, is often slightly coloured with brown, which colour is caused by a parasite species of Alga that sends forth its long twisting filaments into the substance of the ball. The free animalcules, which are extremely lively little creatures, swim about by means of their *anterior cilia*,

and remind one forcibly of the *Stentors*, only that these latter are *surrounded* with cilia, while the free *Ophrydia* possess *anterior* cilia *alone*; in this respect they differ from the true *Vorticellæ*, which develope a *posterior* fringe of cilia before the individuals leave their spiral stalks. I have never seen anything like a posterior fringe of cilia belonging to a free *Ophrydium*, but have observed a peculiar minute setiform appendage at this extremity as represented in fig. C *c*.

If an *Ophrydium* ball be placed in a vessel of water, and be kept in a sitting-room, the animalcules in a few days will leave the gelatinous substance and swim freely about for a time, when they again attach themselves to the bottom and sides of the vessel in small radiating clusters (see fig. G), which, I believe, represents an early stage of globe-like growth. I have never seen the encysted state of an *Ophrydium*. In most of the infusoria are to be seen certain clear spaces of a circular form; these are termed "contractile vesicles," and "vacuoles." These are very readily observed in *Ophrydium versatile*. The "contractile vesicle" (fig. I *d*), which is supposed to be filled with some clear fluid, and which some suppose may serve the purpose of a rudimentary circulation, is situated in *Ophrydium* near the termination of the œsophagus, and dilates and contracts pretty regularly at intervals of eight or ten seconds; the "vacuoles" may readily be distinguished by their non-contracting and dilating properties. The "nucleus," which in *Ophrydium* is an elongated twisting band, and always filled with granular contents, may readily be observed by crushing an individual between two pieces of glass, when the solid "nucleus" will appear. It is now well known to microscopists that the so-called "nucleus" and "nucleolus" of the infusoria have been most satisfactorily proved to be the "ovary" and "testis," by the researches of M. Balbiani.

References to Plate.—A. *Ophrydium versatile* attached to *Anacharis alsinastrum*. B. Portion of surface of ditto seen through lens. C. Free individual swimming by means of anterior cilia. D. Individuals in various forms. E. Granular contents escaping. F. In process of longitudinal division. G. Showing mode of increase. H. Filamentous alga. I. Individual *Ophrydium* magnified 400 diameters:—*b*, mouth surrounded with cilia; *c*, ciliated œsophagus; *d*, contractile vesicle; *e*, nucleus long and twisted; *f*, annular folds of external surface; *g*, longitudinal plaits; *h*, chlorophyll utricles; *i*, vacuole; *j*, non-contractile peduncle.

ALLOTROPY.

BY W. B. TEGETMEIER.

The singular phenomena which are known to chemists under the title of Allotropy are so remarkable, and can be so easily illustrated by means of a few simple experiments, capable of being performed without any particular apparatus, that they may advantageously form the subject of one of the series of practical papers that were commenced in a former volume of the Intellectual Observer.

The term Allotropy is employed to signify the remarkable circumstance, that the same substance can exist in two or more totally different states, which are distinguished from each other by extraordinary variations both in their physical and chemical properties. The same substance, for instance, may be in one state fearfully poisonous, in another perfectly harmless. In one condition it may be brittle, in another extremely elastic. Again, it may have a liquid and several solid states, being in one vitreous or glassy, in another crystalline, and in a third perfectly amorphous. These singular changes of condition are the more remarkable from the fact that any one may be produced at the will of the operator, each particular state being readily convertible into either of the others.

The most familiar examples of allotropic substances are the elements carbon, phosphorus, and sulphur. Of these the latter is most easily experimented upon, and as some new facts relating to its allotropic conditions have recently come to light, we will select it for illustrating this peculiar class of phenomena.

Common commercial sulphur, or that found native in several parts of the earth, is soluble in turpentine in most of the mineral oils, as benzine, and also in bisulphide of carbon; when crystallized, it exists in the form of elongated octohedrons. If a few pounds of the common sulphur be melted in a crucible and allowed to cool slowly until a crust forms on the surface (when the crust should be broken and the liquid exterior poured out), the sides of the cavity will be found to be lined with transparent yellowish needle-like crystals, having a totally distinct form from the octohedral variety, being in long oblique prisms. These crystals spontaneously change in the course of a few days and pass again into the first-named more opaque octohedral form, the crystals retaining their outward shape, but in reality being constructed of an aggregation of minute octohedrons.

This change from the transparent prismatic to the opaque octohedral form is one of great importance in the plastic arts. Sulphur, when melted at a low temperature, and first cast, pos-

sesses a considerable degree of transparency, and a fair amount of tenacity and freedom from brittleness. It can be readily cut or trimmed with a knife, having very much the consistence of a hard horny cheese. Advantage is taken of this by the makers of plaster medallions and the copiers of old coins and medals. They moisten a plaster medallion, or grease slightly the surface of a medal, and then, securing a paper rim around it, pour on melted sulphur. This solidifies into the transparent prismatic variety, and may be cut and trimmed into shape, serving as a mould in which new plaster copies may be cast. After a few days, however, the sulphur resumes its octohedral brittle form, and the attempt to use it as a mould when in this condition generally results in its being defaced in consequence of its extreme brittleness.

Other peculiar allotropic forms of sulphur are produced by melting it at different temperatures.

When heated to a degree not exceeding 120° Cent., sulphur forms an exceedingly limpid mobile liquid, that possesses the property of taking sharper casts than any other substance, hence its employment as previously mentioned.

If it is heated to a higher temperature, it becomes gradually darker and extremely thick and viscid, so that the flask in which it is being melted may be inverted without its running out. The greatest degree of thickness and viscidity is attained at a heat of about 250° Cent. If it be heated to a higher degree it becomes more liquid again, though never to the same extent as when at a lower temperature. If in this highly heated state it is poured in a thin stream into water, sulphur assumes the extraordinary form of a rich amber brown transparent substance, possessed of a very high degree of elasticity and capable of being drawn out into threads. In this extraordinary condition it is quite insoluble in bisulphide of carbon and other menstrua that so freely dissolve octohedral or common sulphur.

In the course of a few hours, however, it returns to the common brittle condition, the change being accompanied by the evolution of heat, and, what is very remarkable, this change may be instantly brought about by placing the elastic sulphur in boiling water.

In the elastic state, sulphur is evidently in the vitreous or glassy form. This form is dependent on the fact that the sulphur has united with a proportion of heat, which has become latent in effecting this change.

A very good illustration of the vitreous condition assumed by some allotropic substances exists in barley sugar. This is formed by boiling sugar with the smallest possible quantity of water capable of dissolving it when aided by heat; as thus formed it is, whilst heated, a soft vitreous substance, capable of

being twisted in spiral sticks, or formed into any required shape.

The proof that this peculiar condition is owing to latent heat is very convincing. If a mass of moderately warm barley sugar be taken and pulled out to double or treble its length, then folded and pulled out again and again, it eventually loses its transparency, becoming converted into penides, or pulled sugar, as it is technically called. But to pass from the vitreous condition it must get rid of its latent heat, and therefore, as the change is accomplished, the whole mass throws out this hidden caloric, becoming so hot that the hand cannot hold it.

To return, however, to the elastic state of sulphur: this condition may be rendered much more permanent by the addition of the minutest portion of iodine to the sulphur whilst melting. The smallest particle of iodine renders the limpid melted sulphur of a dark colour, and seems to be retained in spite of the high temperature to which it is necessary to raise the sulphur previous to pouring it into water. This iodized sulphur is much more elastic than that which has been fused and cooled without the iodine.

By many chemical authors this elastic sulphur is called *plastic* sulphur, an absurd misnomer, inasmuch as plastic signifies that which can be moulded into any required form, certainly not a property of elastic sulphur; and, misled by this absurd title, one of the best known writers on chemistry states that it is in this condition that sulphur is used for taking casts!

These changes, though not all of which sulphur is capable, serve very well to show the remarkable allotropic changes of which many substances are susceptible. That the same body should, without any alteration of its composition, be able to exist in the apparently opposite states of extreme brittleness and high elasticity, of transparency and opacity, of solubility and insolubility, in octohedral and in prismatic crystals, in a state of extreme limpidity and in one of great viscidity, is a very remarkable circumstance, and one worthy of being investigated with much greater care than it has yet received.

ELECTRICAL RESEARCHES BY DE LA RIVE AND GASSIOT.

M. DE LA RIVE has transmitted to the French Academy an account of his researches into the phenomena of the transmission of electricity—obtained from a Ruhmkorff coil—through rarefied gases. He states that the gas on which he operates is placed in tubes 4 or 5 centimeters in diameter, and 15 to 100 centimeters* long; or in vessels 16 to 20 centimeters wide, and from 20 to 25 high. In the longest tube, the platina balls, serving as electrodes, may be approached or brought into contact, as the wires carrying them pass through leather collars. His experiments on the influence of rarefaction on resistance to the discharge agree pretty well with those of other observers, but he adds that when the rarefaction approaches that degree which corresponds with most perfect condensation, the gases on which he operated—hydrogen, nitrogen, atmospheric air—follow precisely the law of conduction, being inversely as length.

Remarking on the well-known appearance of stratification in air sufficiently rarefied to permit of continuous discharge, a phenomena that begins by slight striæ on the side of the positive electrode, he details the following observations:—

"It is with hydrogen that these striæ appear most quickly and sharply, when the discharge consists only of a rose-coloured thread two or three centimeters in diameter. Gradually, as the elastic force is diminished, the discharge enlarges as well as the striæ. Moreover, a black space, which is also seen to enlarge itself gradually, and which may reach five or six centimeters in length, separates the extremity of the luminous column from the negative electrode, which remains surrounded by a blueish atmosphere. The phenomena of stratification take place in precisely the same way whether the gas be dry, or more or less moist: it therefore does not depend on the elementary, or compound nature of the medium. At a very slight pressure of one or two millimeters, the annular divisions, alternately dark and luminous, which form the striæ, become immoveable and very narrow (a quarter of a millimeter in breadth), while under a stronger pressure they were animated with a decided oscillatory movement, and had a breadth extending to five millimeters. When the pressure is less than two millimeters, a gleam of pale rose appears in the black space, and some luminous rings, which contrast, by their immobility and sharply-defined contours, with the agitated striæ in the rest of the electric discharge; and even at a pressure exceeding

* It is time this word was naturalized, so we spell it English fashion. It is to be hoped our own vexatious measures will not endure much longer.

two millimeters, an attentive examination of the obscure portion reveals a pale light, sharply divided from the luminous stratified column of which it is the prolongation."

M. de la Rive goes on to state the effect of introducing an additional quantity of gas, corresponding to an increase of a quarter or a half of a millimeter pressure. If the introduction takes place on the negative side, annular rose-coloured striations of the same diameter as the column of the discharge appear in the dark space. They gradually propagate themselves through the tube, and entangle* themselves with the primitive striations, which are much broader and less defined. When the supply of fresh gas is stopped, the luminous column slowly removes itself from the negative electrode, and soon regains its primitive appearance. Introducing the gas at the positive electrode, gives rise, in lieu of striæ occupying all the breadth of the tube, to a brilliant jet of very small diameter (two or three millimeters), advancing along the axis of the tube in "the relatively obscure interior of the luminous column, which immediately occupies all the black space in the vicinity of the negative electrode." These experiments M. de la Rive considers to confirm the opinion of M. Riess, that the stratifications are purely mechanical phenomena, resulting from the alternate contractions and expansions produced in the rarefied fluid by the discontinuous character of the electric discharge. He adds that this is shown by the employment of a manometer in connection with the tube, when oscillations varying from $\frac{2}{10}$ to $\frac{4}{10}$ of a millimeter reach a maximum of amplitude, at the moment when the gas reaches the degree of rarefaction at which the striation appears.

In further explanation, M. de la Rive observes that in the rarefied column those bands which are the best conductors remain dark, while those which offer most resistance become luminous; just as in the case of a chain of alternate links of platina and silver, the former become incandescent, while the latter remain cold. To prove this experimentally, he placed in the tube two small disks of platina, so that one should be immersed in a dark space and the other in a light one when the discharge was made. These disks acted as "sounds," and wires connected with them afforded a weak current from the dark spaces, and a stronger one from those which were luminous. He also found a difference of temperature in the two portions of the discharge.

"When a long tube containing hydrogen, at a pressure of eight millimeters, is placed axially or equatorially between the poles of a powerful electro-magnet, the conducting power of the medium diminishes from 30° to 10° if the dark space is near

* En s'enchevêtrant.

the magnetic poles; it does not vary if the part of the discharge near the positive electrode is near the poles, and it diminishes from 30° to 25° if the middle of the luminous column is submitted to the action of the electro-magnet. This effect is evidently due to the concentration produced by the magnet in the obscure portion of the column, for the medium in becoming more dense grows luminous at the same time."

Another point on which M. de la Rive touches, is the "action exerted by magnetism when the electric discharge takes place in a gaseous medium, between the extremity of a magnetized bar of soft iron and a circle of which its extremity is the centre. At a certain degree of rarefaction the electricity manifests itself in the form of a luminous jet, which turns like the hand of a watch with great regularity, and a velocity which may reach one hundred turns a minute. The direction of the rotation depends on that of the magnetization, and on the direction of the current; but if a change in the direction of the magnetization only modifies the direction of the rotation without altering its velocity, a change in the direction of the current modifies both the direction and the swiftness of the rotation. This swiftness is always less when the circle forms the negative electrode than when it forms the positive, which probably arises from a greater friction that results from the spread of the jet over the surface of the circle. The difference of velocity is much greater when the medium is more rarefied, and the spreading (*épanouissement*) of the jet from the negative electrode is more considerable with air impregnated with vapour, there being in one minute at a pressure of—

Pressure in millimeters.	Circle positive.	Circle negative.
8	100 turns	52 turns
10	72 ,,	46 ,,
12	62 ,,	44 ,,

At a certain degree of rarefaction the presence of vapour causes the jet to divide into several jets instead of spreading, and then to revolve like the spokes of a wheel. M. de la Rive ascribes this to a difference of molecular arrangement in air and in vapour.*

Thus far M. de la Rive, who does not seem to have made himself acquainted with the important paper on Stratified Discharges, communicated by Mr. Gassiot to the Royal Society in 1862, and which was briefly noticed by us in our April number.

Mr. Gassiot's experiments were made with an insulated voltaic battery of 3360 cells. The stratified discharge was in appearance precisely the same as that obtained from the in-

* For further details see *Comptes Rendus*, April 13, 1863.

duction coil, and some remarkable results were obtained by the introduction of tubes of distilled water into the circuit. In this manner the number of striæ could be with absolute certainty controlled, the apparently continuous discharge of the battery eliciting the same phenomena of stratifications as the induction coil. Mr. Gassiot's paper, after describing many original and curious experiments, concluded as follows:—

"The form, or figuration of the striæ, and the positions they occupy in the vacuum-tube, appear by these experiments to depend upon two separate and distinct conditions:—

"1st. The power or energy of the battery.

"2nd. The state of tension of the highly attenuated matter through which the discharge is visible.

"The striæ can be controlled, their number increased or reduced, and their places or positions in the tubes altered by the introduction of measurable amount of resistance in the circuit; and thus they appear to indicate the amount of force of tension which exists in a *closed* circuit of the battery, as the divergence of the gold leaves of an electroscope denotes the evidence of tension *before* the circuit is completed.

"In my former communications to the Royal Society I have alluded to the direction of a force in the induction discharge from the positive towards the negative (*Phil. Trans.* 1858, p. 16, sections 57, 58).

"In 1859 I observed that there was also a tendency or indication of a force emanating from the negative wire (*Phil. Trans.* 1859, pp. 140, 142, 153, sections 68, 72, 99); the actual disruption of the particles from the negative terminal also indicates a force; and this disruption is as freely obtained by the continuous discharge of the battery (§ 16) as it is by the intermittent discharge of the induction coil.

"I have always observed that with the lowest state of intensity with which the discharge can be obtained from an induction coil, the striæ are wider apart, and the dark space between the positive and the negative is much extended; under some conditions of the discharge it is the negative, and not the positive, that assumes the dominant character.

"The form of the striæ in the battery discharge, as observed in No. 815, figs. 7, 8, and 9,* presents an appearance somewhat analogous with the stationary undulations which exist in a column of air when isochronous progressive undulations meet each other from opposite directions, and on the surface of water by mechanical impulses similarly interfering with each other.

"*May not the dark bands be the nodes of undulations arising*

* These figures are published in *Proceedings of the Royal Society* for December 11th, 1862.

from similar impulses proceeding from positive and negative discharges?

"Or can the luminous stratifications which we obtain in a closed circuit of the secondary coil of an induction apparatus, and in the circuit of the voltaic battery, be the representation of pulsations which pass along the wire of the former and through the battery of the latter, impulses possibly generated by the action of the discharge along the wires?"

We have appended Mr. Gassiot's remarks to the account given by M. de la Rive of his researches for the sake of comparison. It seems to us difficult, if not impossible, to accept all M. de la Rive's views, and we should like to know whether any practical electrician has succeeded in repeating the experiments by which he imagines he has proved that the dark and light spaces in the circuit resemble the good and bad conducting links of a silver and platina chain. The subject is a highly curious one, and, though we recognize M. de la Rive's great merit in this branch of science, the theory he has propounded demands further investigation. Notwithstanding the great interest and beauty of electrical pursuits, they have fallen into singular neglect amongst the cultivators of science, so that there are now comparatively few private students either in England or France who devote to them the attention they deserve. This is to be regretted, as, though much has been done, more remains to be accomplished, and, so far as apparatus goes, such excellent means were never before placed within our reach.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY CHARLES CHAMBERS.

1863.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
April 1	30·065	43·0	31·5	·67	·196	52·3	28·6	23·7	0, 3, 4	SE by E, E by N, E by N.	·000
„ 2	30·107	46·7	31·5	·59	·196	55·4	30·3	25·1	2, 0, 0	NE by N, N by E, NW.	·000
„ 3	...	...	...	...	...	59·3	31·7	27·6	...	... ...	·000
„ 4	29·947	45·6	40·8	·85	·272	54·0	39·4	14·6	10, 10, 3	SW, W by S, WNW.	·000
„ 5	...	...				53·0	36·4	16·6	...	... ...	·025
„ 6	29·578	45·5	42·1	·89	·284	55·3	47·2	8·1	10, 10, 10	SSW, SW by S, SSW.	·006
„ 7	29·491	43·0	35·5	·77	·226	53·5	41·1	12·4	6, 6, 9	SW, SW by S, S by W.	·050
„ 8	29·656	45·1	43·0	·93	·293	52·2	34·6	17·6	7, 10, 10	SW by W, SSW, SSW.	·010
„ 9	29·775	49·4	48·9	·98	·359	55·4	48·1	7·3	10, 10, 10	SSW, S by W, S by W.	·083
„ 10	29·749	52·7	50·1	·92	·374	61·5	49·7	11·8	10, 9, 6	S, S by W, S by W.	·034
„ 11	29·835	48·9	43·8	·84	·302	57·7	49·3	8·4	8, 10, 10	NW by N, N, N.	·000
„ 12	...	...	...	...	...	58·7	46·9	11·8	...	... ...	·010
„ 13	29·963	48·6	35·5	·63	·226	56·4	42·3	14·1	9, 2, 5	E by N, ENE, E by N.	·000
„ 14	29·913	45·8	42·7	·90	·290	56·7	38·2	18·5	10, 7, 8	SE by E, S by E, —.	·000
„ 15	29·983	50·1	39·6	·70	·260	59·9	33·3	26·6	4, 4, 9	W, S by W, —.	·000
„ 16	28·992	53·3	42·9	·70	·292	62·5	43·0	19·5	10, 8, 9	—, NW by N, NNW.	·000
„ 17	30·109	53·1	41·2	·67	·275	61·1	42·2	18·9	1, 4, 3	NW, W, W.	·000
„ 18	30·206	51·3	42·7	·75	·290	59·0	47·5	11·5	10, 3, 2	SW by S, NE, NNE.	·000
„ 19	...	...	...	...	...	60·5	33·5	27·0	...	... ...	·003
„ 20	29·852	53·8	42·7	·68	·290	63·4	37·6	25·8	8, 8, 3	S by E, SW by S, WSW.	·000
„ 21	29.829	49·9	41·7	·75	·280	57·0	37·4	19·6	3, 10, 10	SW by W, WSW, WSW.	·000
„ 22	29·745	51·4	38·4	·64	·250	59·4	47·5	11·9	10, 7, 3	WSW, W by S, W by N.	·003
„ 23	30·114	48·2	27·1	·48	·167	54·7	39·6	15·1	3, 7, 3	NW, NNW, NW.	·010
„ 24	30·358	47·9	28·7	·51	·177	57·3	34·0	23·3	1, 6, 10	NW by W, NW by W, WNW	·000
„ 25	30·266	53·6	41·1	·65	·275	62·7	45·1	17·6	10, 4, 3	W by N, W, W by N.	·000
„ 26	...	...	...	...	...	63·7	39·6	24·1	...	... ...	·000
„ 27	30·032	53·8	40·2	·63	·266	62·0	40·0	22·0	0, 7, 6	W, W by S, WSW.	·000
„ 28	29·790	45·3	30·4	·59	·188	55·3	46·3	9·0	10, 5, 3	W, NW by W, WNW.	·000
„ 29	29·874	41·7	34·8	·79	·220	49·7	39·4	10·3	10, 9, 7	NW, N by E, NW by N.	·057
„ 30	30·128	39·7	35·8	·87	·228	51·2	38·1	13·1	9, 10, 10	NE by N, NE, NE by E.	·010
Monthly Means.	29·934	48·3	38·9	·74	·259	...	...	17·1	...	...	0·301

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—April 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. A.M. 1	10	2	2	6	8	30	17	8	11	1	8	6	12	13	6	3	2	1	2	1	8	23	5	7	9	5	5	8	13	15	8·2
2	9	2	4	6	8	30	18	9	9	3	7	7	9	5	3	2	5	5	2	2	7	17	9	6	7	4	8	7	8	15	7·6
3	6	1	3	7	7	25	16	8	8	2	9	6	7	1	1	1	3	4	1	2	6	23	9	5	10	5	3	9	6	13	6·9
4	3	1	3	6	10	20	11	9	6	4	7	9	5	4	1	4	4	7	2	1	6	22	7	7	8	5	7	9	9	15	7·1
5	3	1	4	5	10	24	8	6	9	4	4	10	7	3	1	1	4	5	3	3	8	25	9	3	7	4	5	11	3	14	6·8
6	5	1	3	6	11	21	10	6	9	7	4	11	7	1	1	4	3	7	5	1	7	27	6	7	8	4	8	13	7	16	7·4
7	6	2	3	9	15	24	12	8	14	9	3	11	10	1	2	1	2	7	1	1	11	26	9	4	9	5	7	10	12	15	8·3
8	6	2	3	13	19	27	10	9	16	10	3	12	18	9	2	2	5	7	5	3	14	27	15	9	11	8	11	15	16	17	10·8
9	8	4	2	16	20	30	13	12	18	11	5	14	18	8	5	2	4	11	4	3	13	26	18	13	13	9	12	18	19	16	12·2
10	10	8	4	16	17	31	16	17	19	14	7	12	17	5	8	3	5	15	8	2	18	24	20	11	18	8	15	18	16	19	13·4
11	10	13	4	18	23	26	15	20	17	14	7	13	20	6	2	6	7	13	8	5	18	20	21	13	15	8	20	15	15	15	13·6
12	11	10	3	17	21	29	18	18	21	14	9	17	21	4	3	9	9	11	9	13	24	23	23	12	20	10	20	18	18	15	15·0
P.M. 1	10	10	5	16	21	31	21	14	23	16	17	18	24	5	3	10	9	9	9	14	21	22	20	13	20	11	23	17	19	20	15·7
2	9	9	4	17	24	28	22	18	21	13	13	17	24	5	3	9	11	12	10	18	15	24	21	12	19	11	22	28	18	24	15·9
3	15	10	3	14	26	26	20	21	19	14	17	11	21	7	6	7	11	13	12	14	17	24	20	14	19	9	20	20	21	19	15·7
4	21	8	6	12	23	26	21	19	17	10	12	22	17	11	5	7	10	12	9	13	16	18	20	16	17	11	17	22	22	17	15·2
5	17	9	2	11	25	25	18	18	15	9	13	22	18	7	4	7	11	15	11	12	16	21	20	16	16	9	18	21	20	14	14·7
6	19	9	2	14	23	22	20	15	13	7	10	15	18	10	4	7	7	15	10	12	17	18	19	14	16	9	15	19	21	11	13·7
7	18	3	3	9	25	18	17	11	10	6	8	15	12	10	3	3	1	17	8	10	18	15	14	12	10	3	16	18	16	10	11·1
8	14	4	4	5	24	14	14	9	10	10	7	14	12	10	3	3	2	13	7	9	16	9	22	9	9	1	12	12	13	12	10·1
9	9	8	3	5	27	8	11	11	8	11	3	14	9	10	4	3	3	11	6	6	15	8	10	6	6	2	10	12	19	18	9·0
10	8	6	5	4	27	7	8	9	5	8	5	12	12	8	2	5	4	4	3	9	20	8	10	10	6	4	8	9	9	16	8·4
11	3	2	6	6	29	10	7	10	3	6	3	13	9	5	3	6	5	5	1	8	22	8	11	8	5	4	7	10	9	5	7·6
12	2	2	5	7	30	10	8	12	6	7	3	12	10	7	3	4	4	2	1	7	20	8	7	9	5	3	5	11	10	5	7·5
Total Daily Movement.	232	127	86	245	478	542	351	297	302	210	184	318	337	155	78	109	181	221	137	169	348	466	345	236	283	152	284	345	339	356	10·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1868.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
May 1	30·224	46·0	32·5	·62	203	54·7	31·3	23·4	2, 3, 2	NE by E, E by N, E.	·063
„ 2	30·073	50·2	35·2	·59	·223	59·3	35·2	24·1	0, 6, 6	NE, NE by E, NE by N.	·000
„ 3	...	...	...	...	...	63·9	40·5	23·4	...	... ...	·000
„ 4	29·803	56·3	44·4	·67	·308	65·8	49·1	16·7	10, 7, 8	W, WSW, WNW.	·000
„ 5	29·857	53·6	45·3	·75	·318	64·8	46·8	18·0	3, 10, 7	WSW, NW by W, NW by N.	·000
„ 6	29·997	54·9	41·1	·62	·275	65·4	41·5	23·9	8, 8, 2	WNW, SSW, SSW.	·000
„ 7	30·162	54·0	42·4	·67	·287	62·7	45·0	17·7	10, 2, 1	NW by W, N, NE by N.	·000
„ 8	30·311	48·9	36·1	·64	·280	58·6	37·3	21·3	4, 0, 2	E, SE by E, E by N.	·000
„ 9	30·005	54·7	42·8	67	·291	64·4	38·0	26·4	9, 10, 3	NE by N, S by E, —.	·000
„ 10	..	...	...	...	...	60·3	41·4	18·9	...	... ...	·007
„ 11	29·981	49·7	36·0	·62	·230	58·5	41·7	16·8	6, 10, 10	SW by W, SW, SW.	·000
„ 12	29·687	48·6	48·9	1·00	·359	55·6	48·4	7·2	10, 10, 10	SW, SW, SSW.	·118
„ 13	29·627	52·3	45·3	·79	·318	61·2	50·1	11·1	6, 8, 10	SSW, SW by S, SW by W.	·181
„ 14	29·866	51·8	42·8	·73	·291	60·2	46·6	13·6	9, 10, 10	WSW, SW by W, SW by S.	·052
„ 15	29·782	53·3	50·3	·90	·377	61·0	50·5	10·5	10, 10, 3	SW by S, S by W, SW by W.	·063
„ 16	29·901	52·1	44·2	·76	·306	61·0	47·4	13·6	9, 10, 10	SW by S, SW by S, SW.	·100
„ 17	...	...	...	...	...	59·9	47·3	12·6	...	... ...	·005
„ 18	29·876	50·1	44·6	·83	·310	59·5	41·4	18·1	9, 10, 10	NE by N, E by N, NE by E.	·008
„ 19	29·895	40·9	35·3	·82	·224	47·2	42·8	4·4	10, 10, 10	NE by E, NE by E, NE by E.	·323
„ 20	30·070	45·1	40·4	·85	·268	52·7	42·8	9·9	10, 10, 10	NE by N, NE by N, N by E.	.220
„ 21	30·165	48·8	40·2	·74	·266	55·2	46·1	9·1	10, 10, 10	NE by E, NE, ENE.	·217
„ 22	29·994	45·1	33·7	·67	·212	52·8	39·0	13·8	10, 10, 6	NE by E, ENE, NE by E.	·003
„ 23	29·836	47·7	36·7	·68	·235	57·1	37·7	19·4	7, 6, 6	E by N, NE by N, NE by E.	.000
„ 24	...	...	...	...	...	59·9	37·0	22·9	...	... ...	·000
„ 25	29·964	47·9	37·0	·68	·238	55·8	41·0	14·8	7, 10, 10	N by E, NE by N, N by E.	·000
„ 26	30·172	48·0	35·6	·65	·226	58·2	37·0	21·2	10, 5, 4	N by W, E by N, NNE.	·000
„ 27	30·240	57·2	41·2	·58	·275	65·2	36·3	28·9	0, 5, 7	W by S, W, W by N.	·000
„ 28	30·244	59·3	47·0	·66	·337	70·4	46·5	23·9	2, 3, 7	NW, —, W by N.	·000
„ 29	30·174	63·4	53·5	·72	·420	74·7	49·6	25·1	3, 3, 2	W by S, W by N, W by N.	·000
„ 30	30·134	62·0	54·8	·79	·439	70·5	54·1	16·4	10, 10, 10	W by N, W, W by N.	·000
„ 31	...	...	...	...	...	56·8	52·8	4·0	...	... ...	·013
Monthly Means.	30·002	51·6	41·8	·72	·287	...	...	17·1	...	... ...	1·393

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—MAY 1868.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12																																
A.M. 1	3	8	6	3	10	4	3	2	8	2	3	20	11	18	18	14	6	1	25	24	10	8	7	4	9	2	2	4	6	6	4	8·1
2	3	6	5	2	7	6	7	2	6	5	4	25	12	15	13	9	6	3	25	17	9	10	6	1	8	4	1	5	3	2	6	7·5
3	3	7	8	2	6	4	5	3	3	3	3	25	10	18	13	10	6	2	25	18	11	6	10	4	8	2	1	4	4	6	5	7·6
4	4	5	9	3	7	6	5	3	3	4	1	26	5	16	10	12	3	2	25	20	12	10	10	3	8	2	2	5	4	6	3	7·6
5	2	7	8	4	10	4	3	2	2	5	2	24	6	16	9	13	4	1	25	19	11	11	10	3	12	4	3	7	5	4	5	7·8
6	2	6	1	1	8	6	6	1	1	2	5	14	8	11	9	16	7	2	30	16	10	18	9	6	13	3	2	5	6	4	5	7·4
7	2	10	7	3	11	5	7	7	2	1	7	12	9	16	10	19	8	3	30	13	14	18	13	7	17	9	3	6	7	6	7	9·3
8	12	14	9	10	16	6	9	12	7	8	8	11	16	13	11	25	10	5	28	11	15	25	20	10	20	12	3	7	7	5	13	12·2
9	16	17	9	8	16	3	8	8	5	10	7	16	19	14	14	29	9	9	30	8	18	20	18	10	18	12	7	5	9	4	14	13·6
10	15	13	9	6	17	3	8	16	10	10	10	17	21	16	15	17	9	11	32	8	17	17	19	8	14	11	7	6	8	4	13	13·5
11	11	20	10	10	18	4	10	17	13	13	12	23	20	14	19	17	10	13	38	10	19	18	15	7	16	8	8	5	9	8	13	13·8
12	14	21	10	7	19	5	12	14	11	13	11	30	27	16	19	18	17	17	39	8	18	22	16	7	19	9	10	6	11	9	10	15·0
P.M. 1	17	24	9	10	19	6	9	14	12	12	14	30	29	18	14	21	17	14	43	8	19	17	15	9	22	8	10	9	13	9	11	15·5
2	14	25	10	12	19	10	12	18	7	14	18	29	29	22	13	20	18	12	43	3	19	20	16	11	21	9	11	8	13	10	12	16·1
3	19	25	7	11	15	12	11	17	9	14	21	25	32	23	15	20	13	11	37	8	16	18	14	9	22	6	9	6	13	9	9	15·4
4	21	25	9	11	10	16	11	19	3	13	22	22	31	20	22	20	12	11	35	7	15	17	15	10	16	9	10	9	13	11	8	15·3
5	18	25	8	11	9	12	16	21	1	11	25	21	31	23	26	13	13	16	38	6	15	21	12	11	17	7	12	9	11	9	10	15·8
6	14	21	8	8	5	9	16	16	1	10	24	20	20	18	24	13	12	12	35	15	17	17	10	9	15	8	10	8	10	8	11	13·7
7	15	20	2	8	7	10	15	19	5	6	23	21	15	14	10	13	7	23	36	6	17	16	9	9	14	6	7	6	9	8	7	12·4
8	10	17	2	6	8	9	11	13	4	4	21	23	14	14	10	10	6	22	31	5	20	17	4	8	12	3	6	4	7	7	6	10·8
9	7	13	1	9	5	5	14	7	3	7	21	17	10	18	8	4	6	21	28	7	13	15	7	8	12	1	3	3	7	7	7	9·5
10	9	14	1	7	4	5	12	9	1	7	18	19	11	25	7	6	6	20	32	10	9	15	5	8	7	2	6	4	5	6	11	9·7
11	11	8	1	7	6	5	9	10	2	7	25	15	12	29	11	7	5	23	37	10	9	10	7	4	8	2	5	6	6	4	14	10·2
12	7	6	4	8	9	4	5	9	1	5	25	12	7	19	14	7	3	24	24	10	6	7	3	10	5	1	8	5	8	8	12	8·4
Total Daily Movement.	249	357	153	167	261	159	224	259	120	186	330	497	405	426	334	358	213	278	771	267	389	368	270	176	383	140	141	142	189	155	216	11·4

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A. M., 2 P. M., and 5 P. M. respectively.		
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A. M. on the following day.	Minimum, read at 9·30 A. M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A. M.
	inches.	°	°		inch.	°	°	°			inches.
June 1	30·207	54·3	44·4	·71	·308	65·7	44·6	21·1	10, 4, 3	E, ——, E by N.	·000
" 2	30·058	62·7	48·2	·52	·295	72·4	42·3	30·1	0, 1, 0	E, S by W, SSE.	·000
" 3	29·950	65·0	51·6	·64	·394	76·1	46·0	30·1	5, 9, 10	S by E, SW by W, SW by W.	·000
" 4	29·963	58·4	39·3	·52	·258	68·6	56·3	12·3	3, 10, 2	——, NW, NW.	·000
" 5	29·872	50·8	50·1	·98	·374	62·3	45·7	16·6	10, 10, 10	W, SW, SSW.	·000
" 6	29·407	51·6	49·7	·94	·369	63·4	52·6	10·8	10, 9, 9	SW, SW, WSW.	·901
" 7	...	...	...	...	...	61·6	49·5	12·1	...	... ...	·167
" 8	29·519	50·1	44·0	·81	·304	62·3	49·8	12·5	8, 7, 6	SW, SW, SW.	·157
" 9	29·769	54·6	44·0	·70	·304	63·7	46·7	17·0	6, 7, 4	SW by S, SW by W, S.	·048
" 10	29·467	55·9	50·2	·82	·376	66·1	49·8	16·3	10, 7, 8	ENE, SE, SSE.	·066
" 11	29·538	53·4	42·6	·69	·289	61·9	49·6	12·3	7, 7, 10	SSW, S by W, SSE.	·098
" 12	29·496	46·7	44·4	·92	·308	60·3	48·3	12·0	7, 10, 10	S by E, ——, ——	·321
" 13	29·773	53·9	45·1	·74	·315	62·8	45.9	16·9	8, 6, 3	W by S, WSW, W.	·232
" 14	...	...	...	...	...	64·9	45·3	19·6	...	... ...	·010
" 15	29·975	57·2	49·3	·76	·364	66·3	55·7	10·6	10, 10, 10	WNW, WNW, W.	·094
" 16	29·932	54·8	54·2	·98	·430	64·2	50·4	13·8	10, 10, 10	SSW, SW, SSW.	·003
" 17	29·864	58·7	46·8	·67	·334	68·8	53·1	15·7	8, 5, 7	NW by W, W, W.	·260
" 18	29·794	58·6	49·8	·74	·371	68·3	49·1	19·2	4, 10, 10	S by W, S, SE.	·000
" 19	29·550	54·6	50·8	·88	·384	67·7	54·4	13·3	10, 7, 7	NE by N, SW, S by E.	1·246
" 20	29·790	58·0	52·0	·82	·400	67·6	53·9	13·7	9, 7, 10	NE by N, NW, NW.	·048
" 21	...	...	...	...	...	71·1	50·8	20·3	...	... ...	·000
" 22	30·029	57·1	55·6	·95	·451	67·1	55·9	11·2	10, 10, 9	SW by W, S by W, S by W.	·009
" 23	30·096	63·1	48·7	·62	·357	73·0	56·6	16·4	3, 4, 2	WSW, SW by W, WSW.	·000
" 24	30·048	60·5	53·9	·80	·426	70·8	55·5	15·3	10, 5, 9	NW, N by W, NW.	·013
" 25	30·110	60·4	47·4	·64	·341	71·3	56·5	14·8	10, 6, 3	NW, W by N, NW by W.	·437
" 26	30·127	58·9	48·9	·71	·359	70·9	49·6	21·3	2, 9, 10	W by S, SW, NW by W.	·000
" 27	29·929	57·3	51·1	·81	·387	67·7	51·7	16·0	10, 7, 2	SW, W by S, W by N.	.016
" 28	...	...	...	...	...	64·7	46·6	18·1	...	... ...	·004
" 29	29·979	57·1	43·5	·63	·298	66·9	48·3	18·6	7, 7, 9	SW by W, W by S, W.	·000
" 30	30·207	57·0	43·1	·62	·294	66·8	46·4	20·4	7, 8, 1	WSW, W, W.	·037
Monthly Means.	29·863	56·6	47·8	·75	·350	...	...	16·6	...	... ...	4·167

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JUNE 1863.

	Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
	Hour. 12																															
A.M.	1	13	7	3	5	6	23	12	12	10	5	25	11	4	7	6	4	7	3	17	4	4	12	10	1	8	2	10	7	4	7	8·8
	2	7	4	2	4	5	18	13	11	9	5	23	10	4	5	7	5	7	3	16	5	5	10	6	1	7	2	8	4	4	6	7·2
	3	4	3	2	5	5	17	12	9	6	5	25	11	8	4	6	4	8	2	16	5	8	12	7	2	4	2	11	4	3	3	7·1
	4	3	4	2	5	4	14	10	9	5	6	20	12	5	4	8	2	7	3	13	4	4	11	6	1	4	2	11	6	3	7	6·5
	5	2	8	1	5	5	12	9	10	8	6	18	11	5	5	8	4	5	3	17	5	7	11	5	3	5	1	16	7	4	6	7·1
	6	2	8	1	5	7	13	11	14	10	9	16	12	5	5	8	2	5	2	16	8	5	11	6	4	7	1	17	8	5	6	7·6
	7	7	5	3	6	9	13	10	16	10	7	15	10	8	5	11	4	3	6	17	11	6	11	9	2	6	2	15	11	7	8	8·4
	8	7	9	5	9	12	10	12	17	11	6	20	11	8	6	14	10	5	6	9	10	7	14	6	2	7	2	18	11	9	7	9·3
	9	8	9	7	5	16	11	13	20	16	12	24	13	9	8	13	8	7	5	9	8	8	11	5	3	8	3	20	13	12	11	10·5
	10	7	15	5	6	15	14	18	18	15	10	22	11	12	7	13	6	8	6	9	8	9	13	6	6	7	5	19	11	11	11	10·8
	11	5	13	6	5	16	15	17	15	14	11	15	12	15	10	13	7	9	8	8	11	14	14		8	8	7	18	12	14	13	11·5
	12	4	12	9	5	21	15	16	26	17	16	18	9	15	10	12	9	9	8	11	12	15	15		5	9	11	18	14	18	12	12·6
P.M.	1	5	12	10	8	20	15	23	27	23	15	24	6	13	11	10	12	8	9	10	11	15	16			8	11	19	13	11	13	13·5
	2	7	13	9	12	20	18	23	26	21	15	26	9	17	9	12	15	9	9	6	10	14	18	33		7	12	18	13	12	12	14·0
	3	4	13	8	13	20	12	28	27	22	13	27	4	17	8	12	17	10	9	5	13	15	18		19	7	12	17	11	12	12	13·3
	4	11	14	9	12	23	13	19	22	21	11	24	1	18	10	10	13	10	7	5	11	16	17			8	13	16	7	11	12	12·6
	5	18	17	9	15	25	17	21	21	18	16	24	3	16	6	12	12	9	8	9	8	17	18	5	6	10	12	19	10	8	13	13·4
	6	20	14	11	14	25	17	9	21	14	18	18	2	15	7	12	15	10	8	6	5	14	16	5	6	7	7	18	9	8	10	12·0
	7	13	9	8	12	25	18	13	23	10	16	14	6	13	6	10	11	13	7	7	7	15	14	5	7	6	8	14	7	11	10	11·3
	8	12	6	3	17	23	9	16	22	9	21	14	4	8	8	10	10	10	7	7	5	11	13	2	6	1	9	11	7	8	7	9·9
	9	12	2	5	8	24	9	15	13	6	19	10	5	11	8	8	9	7	6	5	4	12	16	3	4	1	10	10	3	4	3	8·4
	10	12	2	7	8	20	9	16	14	3	24	10	4	7	8	6	7	7	7	8	6	12	14	2	7	1	9	10	3	3	4	8·3
	11	10	5	6	7	22	11	15	17	6	28	9	1	9	8	3	8	6	10	8	5	12	14	1	5	2	10	9	5	6	5	8·8
	12	7	4	8	8	21	10	14	11	8	29	9	3	8	7	4	8	5	11	7	4	9	10	1	4	3	10	8	3	4	4	8·1
	Total Daily Movement.	200	208	139	199	389	333	365	421	292	323	450	181	250	172	228	202	184	153	241	180	254	329	123	102	141	163	350	199	187	202	9·9

THE STUDY OF MOSSES.*

THE most obtuse observer cannot wander through the country without admiring the beauty of mosses. In many places they carpet the ground with a rich living pile of pleasant green, in others they clothe the rocks, form a vesture for the tree-trunk, enrich the parti-coloured thatch on the quaint old cottage, or sedulously haunt the crevice of the wall. In a technological sense they are not of much use, except in the condition of peat; perhaps simply because man is not yet sufficiently instructed to know what to do with them: but in the world of nature they play an important part, making their appearance at times and under circumstances when higher forms of vegetation would not grow. Thousands and millions are the tons of mineral and aeriform matter which they transmute every season into their delicate tissues; and when these decay, they produce no inconsiderable amount of vegetable soil. They likewise form the home and shelter for numerous minute insects, even for rotifers; and they tell their story of the wonderful ways of life and organization not less strikingly than the widest spreading, or the loftiest soaring, of the stateliest families of trees. Like all low, or comparatively lowly members of the organic world, they contribute most importantly to our knowledge of the laws, processes, and structures that distinguish living beings. We cannot assert that they constitute a page of nature's primer, and furnish elementary lessons in A, B, C, for her human pupils to study; as little was known, or could be known of them, or of objects standing upon a similar or lower grade of structural rank, until science had been considerably advanced, and instruments like the microscope had been fabricated to assist in the delicate and complicated labours of research. The simplest form of life is not after all simple in any ordinary sense of the word. We talk of "unicellular plants and animals," but Professor Karsten† tells us this is erroneous, "owing to the complicated structure of the tissue cells which enter into the composition of developed organisms;" and if we mastered the structure of the cell, we should still be puzzled to account for the functions which it performs, some of which we know to be physical, while we call others "vital," without attaching any precise or definite meaning to the term.

Still, though nature's secrets lie always deep, we are

* *Handbook of British Mosses*, comprising all that are known to be Natives of the British Isles. By the Rev. M. J. Berkeley, M.A., F.L.S., author of "Introduction to Cryptogamic Botany," "Outlines of British Fungology," etc. Lovell Reeve & Co.

† See *Annals of Natural History*, No. 67.

materially assisted in unravelling them by the examination of objects that present fewest complications; and hence, among others, mosses are very useful to the scientific botanist, as they are sure from their beauty to interest the more casual observer. Unfortunately, they do not readily admit of any classification which is natural and intelligible. In the *Micrographic Dictionary*, which has a high reputation for its botanical articles, the system of Müller is followed, while Mr. Berkeley considers that the arrangement of Dr. Montagne in *D'Orbigny's Dictionary* is the most convenient as regards the natural orders, and he tells us he has adopted it with few exceptions. He arranges the mosses under four orders—*Pleurocarpi*, with the fruit lateral and springing immediately from the stem; *Acrocarpi*, with the fruit terminal; *Schistocarpi*, with the fruit splitting longitudinally into four or more valves, adhering above; and *Syncladei*, mosses with fasciculate branches. The artificial group, *Cladocarpi*, with terminal fruit on short lateral branches, he judiciously arranges under other heads, on the ground that "it is not strictly natural, and the character is difficult of application, as *Acrocarpus* and *Cladocarpus* species occur in the same genus."

The shape of the spore vessel or capsule, the form of the hood, the presence or absence of the peristome, and its exquisite rows of finely-coloured teeth, the shape of the cells forming the leaf tissue, and the mode of branching—these are the chief points to be attended to in the examination of mosses; but it is to be regretted that as yet no sufficiently dominating characters have been discovered to enable those who have devoted themselves to the inquiry to establish genera which are at once intelligible, and correspond with natural conditions.

Mr. Berkeley, who is no mean authority on these subjects, after devoting, as his present work proves, much attention to the question, tells us that "on the whole, the state of Bryology must be considered as extremely imperfect," and he adds, "the entire subject clearly wants the revision of some master mind."

The reproductive processes in mosses are very curious and characteristic. As is common with plants, and with many animals, they have two or more modes of multiplication—the one a genuine sexual process, the others belonging to the category of *budding*. In the elegant urns, which form such beautiful objects for the microscope, the moss produces *spores*; but the result of their germination differs materially from that of the spores of ferns. Mr. Berkeley thus comments upon this subject:—"In ferns and their allies, the result of germination is the production of a cellular expansion of various forms, whether globose, or scale-like, or irregular, whether more or less differen-

tiated and distinct from the spore itself, or confluent with it externally or internally, or both, on which, or within the substance of which, at least in the more normal cases, two organs are produced of different sexes, the one of which, called an "archegonium," consists of a pitcher-shaped cyst, within which there is a free single cell at the base, which is destined, after impregnation, to produce first an embryo, and then, by continued development, a perfect plant like the parent. . . . In mosses, on the contrary, and their allies, the object, after germination, is to form a more or less filamentous, or scale-like stratum, resembling either a little green lichen, or one of the verdant thread-like confervæ, such as *Lyngbya muralis*, which clothes damp trees or the soil at the base of walls on the northern side, or that which is least exposed to the direct rays of the sun; and when this is perfected, nodules appear, which by cell formation give rise to the proper plant, whether symmetrical or unsymmetrical, whose office is to produce fruit. On this plant, then, either in the same or in distinct individuals, male and female organs are produced, resembling more or less closely the antheridia and archegonia of ferns. In the latter there is a cell at the base analogous to that in the archegonia of ferns, which is destined to be fertilized by spermatozoids formed in the tissue of the antheridia." The result of the fertilization is, however, distinct from that of ferns, for in their case germination produced a prothallus and impregnation afforded a true plant, "whereas in mosses and moss allies the cell division of the basal cell of the archegon* is a sporangium, or, as it is frequently called, a capsule or theca, which, with various modifications, gives rise to spores."

Warmth and moisture cause moss spores to burst their outer membranes, when the inner one puts forth an elongation which forms a green thread, and from these threads fertile buds arise. The behaviour of these threads has attracted the attention of Dr. Hicks, but Mr. Berkeley does not accept that gentleman's conclusions. He says:—"Dr. Hicks, in the 23rd vol. of the *Transactions* of the Linnean Society has described wonderful changes which take place in these threads, and their conversion into several genera of algæ, besides the formation of zoospores; but as he does not identify the species to which he observed the threads belonged, and the production of zoospores is a circumstance so extremely anomalous, we find it difficult to believe that he had really portions of some moss before him, and not the threads of algæ accidentally intermixed."

Many mosses are readily cultivated, and afford elegant "adornments" for what our friend Shirley Hibberd calls

* The archegon is the rudimentary organ which represents the ovule in the higher flowerless plants.

"Homes of Taste." Mr. Stark gives a long list of these, amongst which are species of Hypnum, Orthoslichum, Polytrichum, Trichostomum, Andrea, Bryum, etc., etc. Of course the natural habits of the mosses must be considered, some liking a large allowance of moisture, and others preferring a situation that is dry.

We do not think it is any argument against a system of classification based on minute structure, that the determination of genera or species requires the aid of the microscope, as, thanks to the competition amongst excellent makers, instruments sufficient to follow the researches of others can be obtained for very moderate prices, and nine-tenths of the pleasure which the moss tribe, or any other small plants whose parts are minute, are able to afford to their admirers, must be obtained through the medium of considerable magnification. On this ground we confess to have some leaning towards the system of Müller, but every arrangement in the present state of the science must be regarded as provisional, and the consolation for those who have to take the trouble of getting up an elaborate nomenclature, to find it replaced a few years hence by another, must be found in the fact that they cannot study mosses upon any system without obtaining a large amount of positive information, which must remain valuable, whatever additions may be made to the store, or whether other genera are destined to suffer the fate of *Gymnostomum*, and find themselves properly distributed amongst widely distant groups.

In Mr. Berkeley's work the student will find the inestimable advantage of several hundreds of beautifully-executed coloured figures of native plants, and of their most important parts. By these he will be materially assisted in the determination of species, and also instructed what to see with the microscope in the arrangement and form of cells, the character of the spore vessel, the peristome, etc., etc. It is also proper to state that although Mr. Berkeley modestly disclaims originality, he has personally examined the objects described, and written his account of them with the especial purpose of assisting the collector of British specimens. The work is handsomely printed, and the coloured illustrations of unusual merit.

THE SOURCES OF THE NILE.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S., ETC.

In our number for June appeared a brief notice of a few words, announcing the intelligence that Captain Speke had succeeded in identifying the African lake, Victoria Nyanza, before visited by him, south of the equator, with the great father of waters, old Nilus; thus solving a very important section of one of the most important of all geographical problems, and obtaining for England and the nineteenth century a reputation for discovery that the wisest of the ancient Egyptians and their conquerors from the earliest days of civilization have failed to secure.

Since those few lines were written Captain Speke and his fellow-traveller, Captain Grant, have returned to England, and have communicated some of the main results of their long, arduous, and dangerous expedition. Before giving an outline of these, let us briefly review the previous state of the problem and the extent of the work really done. Besides being of the highest interest as a question of descriptive geography, the results of exploration in north-eastern Africa, as commenced by Captain Burton and Captain Speke, and now continued and nearly completed by the latter, are of the most extraordinary interest, and help us to understand the physical geography and resources of a large section of the African continent. The key to the explanation of all that is peculiar to Africa has been now obtained by the combined labours of Livingstone, Burton, Speke, Grant, and Petherick.

It was towards the end of June, 1857, that Captain Burton and several companions left the African coast near Zanzibar, on their way into the interior, determined to attempt the discovery of the sources of the White Nile from the east and south, instead of repeating the attempts that had been so frequently and unsuccessfully made to trace the river by following it up stream.

From the time of Herodotus downwards there had been vain attempts made by European explorers to discover where the waters of the great river originated, and what was the cause of that mysterious rise by which Egypt was flooded and fertilized. No doubt the traders from Arabia have crossed all parts of northern Africa from the east to the centre, and they may even have reached the west coast, but no information could be obtained from them but the vaguest reports. Accepting these implicitly, and interpreting them naturally and without theory, there had been maps prepared during and since the middle ages, which are really as correct as any maps

could be without accurate observations. In other words, they express vaguely the fact that the country is covered with numerous lakes near the equator, and they do not allude to mountains. But this was opposed to all prevalent notions, and, as in other more familiar districts, great rivers originated in lofty mountains, so in Africa, where the ancient geographers had spoken of "Mountains of the Moon," it was concluded that there must be a lofty central chain, and all the ideas of the Nile were modified by this assumption.

In the year 1768 Bruce proceeded to Egypt to trace the Nile from its outlet to its source. It was then known that at a certain part of its course there were two great feeders of the river, one of which was called the Blue Nile, and this was known to proceed from the Abyssinian mountains. The other, the White Nile, was believed to be comparatively unimportant, chiefly from the theoretical reasons alluded to, though partly because its importance really seems to be masked near the junction. When, therefore, Bruce in Abyssinia visited the head waters of the Blue Nile, he thought he had solved the problem of antiquity.

It was soon found out, however, that the White Nile must also be followed, and its history ascertained. Recognized at an early period as an important branch, it ultimately became evident that it was the real river, and, although obstacles to its navigation existed, and there were great difficulties in exploring it, owing to the numerous savage tribes in that part of Africa, it was a geographical necessity that the source of the river must be sought for much nearer the equator than Bruce had imagined. Exploring parties were organized, and great efforts made by the Egyptian government between the years 1835 and 1841, the result being a doubtful and greatly questioned discovery, which may be considered, however confirmed, at least in its chief points, by Captain Speke, that in latitude 3° 40′ north, and at a distance of more than 3000 miles from Alexandria, the river was still a wide stream, broken by a series of cataracts, coming from a distance described as thirty days' journey in the interior. The longitude, however, of this furthest point of the expedition was not clearly determined, and it may still be that some feeders coming in from the west may help to drain the interior of the continent halfway between its eastern and western shores.

Among the discoveries of other explorers, partly confirmed by the subsequent researches, but still in some measure doubtful, owing to the want of accurate observations of latitude and longitude, may be mentioned the statement published by Mr. Petherick, British Consul at Khartoum, who, in several trading expeditions, and with much personal risk and trouble,

advanced almost to the equator from the Bahr-el-Ghazal, a remarkable lake or expanded arm of the Nile. Mr. Petherick describes a country without great undulations of the surface, traversed by a westernmost branch of the Nile, which he believes to meet the White Nile in this expanded swamp.

When, then, in 1857, Captain Burton and his enterprising companion, starting from the east coast at Zanzibar, between 6° and 7° south of the equator, decided to go so far into the interior of Africa towards the west as to cross the direction of any north and south water-course, or mountain chain, and lay bare the geography of that part of the continent, they really had to make discoveries at every step. There was a certain idea, prevalent already in the minds of geographers, that the east as well as the west coast of Africa contained much elevated land, but that there were no great mountain chains in the far interior. The lofty mountain chain reaching southwards from Abyssinia, broken, perhaps, here and there, but culminating in the snow-covered peaks of Kilmanjoro, descends to form a range of mountains from 6000 to 8000 feet in height, connected with a plateau of inferior but considerable elevation, commencing about 150 miles from the coast, and of great width. Beyond this and further to the west the ground descends considerably, and there is no evidence of any mountain chain in this direction. Within the plateau, which is here 120 miles wide and 4000 feet above the sea, is the large and remarkable lake visited by Captain Speke in 1858, and described as the Victoria Nyanza. Beyond it to the west is another great lake (Tanganyika) at a very much lower level, connected apparently with other lakes to the south, and having no communication with Nyanza.

After Captain Speke had reached this lake in 1858, and had compared notes with Captain Burton, who had by that time visited and explored the more westerly lake of Tanganyika, he was convinced that by continuing northwards from the southern shore of the higher lake, he should find that its waters communicated with the Nile. Unable then to decide the point, he was obliged to return to England; but shortly afterwards, expeditions were organized on the one hand to enable Captain Speke to continue his investigation as suggested, and on the other to secure assistance, should he be able to cross the equator, and fall in, as was most likely, with troublesome native tribes inhabiting the country already partly described by Mr. Petherick. It was not till the end of 1861 that Captain Speke, accompanied by Captain Grant and a long train of native attendants, reached once more the southern extremity of the lake, on whose exploration so much depended. He then passed round the lake to the west, and found there a network of ponds and lakes, all

receiving streams from the south, and pouring them into the Victoria by a channel, which also in its course receives the drainage of several other lakes. The river thus fed is a considerable stream before emptying itself into the Victoria. It runs through a deep ravine, eighty yards wide, and flows at the rate of five miles an hour. The sources of these feeders are said to be in an extensive tract of mountain-land, situated north of the great lake of Tanganyika, described by Captain Burton, and receiving very large supplies of rain, which may probably be periodical. These mountains do not seem to have been visited.

Should this view be correct, it would seem that the main chain crossed in travelling from the coast turns round, and extends westward, representing, in fact, the chain, though probably of no great elevation, so often described as the "Mountains of the Moon." Captain Speke reports that in the year 1862 there were 238 days in this district on which rain fell, and the high lands would seem to supply at all seasons a very large body of water to the elevated lakes terminating in the Victoria Nyanza. The eastern side of the lake is said to consist of low hills intersected with deep ravines, and a large island is spoken of by the native traders as existing in another and smaller lake in this direction, from which salt is procured. The waters of all the lakes are sweet.

From the great lake thus fed by numerous streams, entering by innumerable channels, the White Nile issues. It proceeds from a point situated midway along the northern shore. The stream, as it emerges from the lake and enters on its course, first leaps over a vast heap of plutonic rocks, falling about twelve feet into the plains below. From this point, called by Captain Speke the Ripon Falls, the Nile has cut a channel through sandstone hills for some distance, and continues to run towards the north with great impetuosity. It loses itself for a time in marshes of vast extent, which present the appearance of a lake (like the Bahr-el-Ghazal, and other swamps much further to the north), receiving at various points tributary streams of considerable magnitude. It remains, however, a navigable stream for some distance, until it again falls in a large cataract into a district sloping rapidly to the west, where the river once more flows with great rapidity. Here, however, Captain Speke and his companions were compelled to leave it, owing to the troublesome character of the people on the banks. After joining it again at Madi, the travellers found the course to continue as before, receiving the important branch called the Asoua on the right bank, and the Bahr-el-Ghazal, at some distance beyond, on the left. The latter is a very large branch, and may perhaps be a more important affluent than is supposed.

It is at any rate so far important that its junction with the White Nile is marked by very extensive and almost untraversable swamps. As an incoming affluent, it appeared to be almost without current, but this might be owing partly to the greater impetuosity of the main stream checking its course, throwing its waters back, and producing the large expanse of swamp. Several tributaries of various magnitude enter the White Nile from the east or right bank, but these are connected with the drainage of the mountains in that direction.

It is quite evident from this account, *First*, that the principal tributaries of the White Nile come in from the high lands surrounding the Lake Victoria Nyanza, near the equator. *Secondly*, that the mountain chain to the east includes the lofty snow-covered mountains, probably volcanic, described by the German missionaries, and probably continued as a coast range, passing to the south and east of Nyanza. *Thirdly*, that the main sources of water supply are not far from these high mountains, but proceed from lower intertropical and sub-equatorial ranges separating the plateau from the lake system of Tanganyika, described by Captain Burton. All the chief swamps, the deltas, and the complicated channels are spoken of by Captain Speke as coming in from the west and south, while only three or four complete rivers enter from the east; and, moreover, both the main river entering the lake, and the stream emerging from it towards the north, appear to be very much larger and more rapid than any other tributaries. *Fourthly*, that there is a certain obscurity still left as to the river (not the swamp) called Bahr-el-Ghazal, both as to direction and importance, for it is possible, though perhaps not very likely, that this stream comes in from the far west. *Fifthly*, that the old question of the existence of a chain of mountains crossing the African continent is almost revived by this recent discovery of Captain Speke, although it had been more than questioned by most modern geographers. It is still possible that the great abundance of running water feeding the lakes may come from such mountains, and may be the result of a long line of slopes stretching away into the interior of the continent. But though possible, all analogy and probability are opposed to this assumption; and it is much more likely that the apparent chain is a termination northwards of the plateau which dies away in the great Sahara.

The native tribes met with by Captain Speke, on the north side of the lake, seem to be connected with Ethiopia ethnologically, but offer many points of great interest. They are even regarded as descendants of the ancient Ethiopians, and they retain a curious tradition of their ancestors being half black, half white, and having half their hair crisp and woolly, and the other half straight and lank. There is no doubt that this rela-

tion rather tends to indicate a natural hill-boundary between the tribes to the north and those to the south of the equator. Captain Speke reports that, in this strange government, uncleanliness and ingratitude are regarded as capital crimes; that a female guard surround the king; that this potentate must not be approached in any other than the most lowly attitude, and that not even the presents made to him must be exposed to vulgar gaze.

Since Captain Speke's return, a French traveller, M. Miani, writing from Venice, has endeavoured to throw doubt on the importance of these results, by a statement to the effect that the principal branch of the White Nile is one of the streams that proceed from the mountains to the east. That the extremely lofty mountain chain, occupying this position, supplies very large feeders, is by no means unlikely, and that during certain seasons, when the summer sun dries up many streams, it may, by melting the snow on the steep sides of Kilmanjoro, largely increase some other sources of supply is not improbable, but the general result of Captain Speke's investigations seems based on observations too accurate to permit of this error. The results of M. Miani's visit to the other sources cannot fail to be full of interest, especially if they introduce us to the upper valleys of the snowy range, of which we at present only know that it exists.

Many are the expeditions that have been made from the Upper Nile in search of adventure and discovery in this remarkable and mysterious river. Mr. Petherick, already alluded to, believes that he reached the equator at a point distant only sixty miles from that known to be crossed by the Nyanza, a fact of great importance if true, but which requires confirmation, owing to his not having had instruments to determine his position with accuracy. The Egyptian expedition was, in like manner, and for similar reasons, untrustworthy. In the early part of this year a very remarkable enterprise was undertaken by three Dutch ladies, Madame Tinne, her sister, and daughter, who embarked at Khartoum on a small steamer, accompanied by four other ships, carrying in all as many as 200 persons, and proceeded up the Nile with a view to trace the westernmost affluents. Among the companions of these ladies were two travellers, M. de Heuglin and M. Steudner. The ladies had previously visited Gondokoro (within 4½ degrees of the equator), and had made excursions from thence. They have now passed the Bahr-el-Ghazal, and having entered the river of that name, are endeavouring to advance into the interior. As far as the sheet of water called Lake Rek, about 600 miles south-west of Khartoum, the country is known, but all beyond is still mystery. The remarkable tribes of the Niam-niams, who inhabit this part

of the continent, are said to form three tribes—one of them inhabiting a mountainous and wooded country, and working iron and copper, whose ores are found in the soil. Some people of another of the tribes are said to have rudiments of a tail, and the third are said to be of comparatively white colour, and, although living almost under the equator, far more intelligent and active than is usual among native Africans. M. de Heuglin, travelling as we have said with the ladies Tinne, believes that these reports are not without foundation.

Although, then, one more of the main sources of the Nile is certainly discovered, and this gigantic river has now been followed in a north and south line from the Mediterranean to the equator, although the Blue and the White branches are traced to their hiding-places, and the sources of many of the other tributaries must be regarded as settled, yet, in spite of all this, there are still unexplained mysteries, and sufficient left for future travellers to see and describe.

The problem of the interior of Africa still, therefore, remains to be solved as regards some sufficiently important details, but it is gratifying to know that a few of these are in the way of being settled shortly.

The great water system of Africa is now much better understood than it was a few years ago, and the mystery that connected itself with African geography is being rapidly dispelled. Dr. Livingstone has crossed the continent, and by following the course of the Zambesi and some of its tributaries, he has prepared us to understand a system of drainage quite different from that of Europe, Asia, and America. Much that is most remarkable both of vegetable and animal life in Africa, not only with regard to the lower animals, but man, must be referred, and can be explained by a reference to this condition. There is now no need to assume high mountains in the interior, for Africa is a basin, vast, no doubt, in extent, but simple in its plan, and the river systems are all derived from the broad elevated rim of this basin. Within this rim, four or five hundred miles wide, and varying in height from four to ten thousand feet, though not without lofty exceptional peaks, there is enclosed a space—the whole of Central Africa south of the equator—within which are formed, and through which run large streams, only able to escape at one or two points where the rim is broken. Whether the Nile communicates with this network of the interior has lately been a question. On the one hand, there were the great lakes, probably, as it seemed, connected throughout the east coast, and the apparent absence of any extreme difference of level between these and the northern river. On the other hand, was the mysterious flooding of the Nile, the constant outpouring of its waters towards the north, and the ab-

sence of any rational explanation of many well-known phenomena. All Africa contains but a few rivers of importance, and of these, not one besides the Nile is a first class stream as it enters the sea. The Niger is choked, the Zambesi is choked, and the Zaire is hardly visible. None assume the character of a wide rapid river, pouring an incessant stream, unbroken and unchanged by events going on in the interior of the continent, and hardly one is continuously navigable.

We are now beginning to see in what the Nile resembles, and in what important points it differs from the other principal rivers of the world and the streams of Africa. Unlike other rivers, for the last thousand miles of its course it receives no tributary. Exposed to the drying winds that have crossed the desert either of Africa or Arabia, it yet preserves its water supply with unvarying regularity, and when the usual season comes it rises rapidly, and overflows a large tract of low flat land. It bears down from the interior of the country a vast amount of mud to fertilize these plains. Silent and inaccessible, for ages the sources of this stream have been looked for, and some mountain system worthy of so gigantic a result has been from the earliest times hypothetically named and described. It is hardly too much to say that no such system exists. Mysteriously generated under the burning and vertical sun of Central Africa, fed by a network of streams draining an extensive, richly wooded, and not lofty table land; here and there expanding into swamps crowded with the hippopotamus; at intervals rushing along through ravines, or falling over rocks and ledges; always large, always full, always important, this river, a giant from its birth, is the outlet of a group of lakes, and is thus connected with the peculiar drainage system of its continent. As it emerges into the lower land towards the north it is also flanked by the loftiest mountains of the continent, with their summit peaks covered with perpetual snow, and receives from them a supply which never fails, and which is greatest in the greatest heats of the tropical summer. But the tropics have no winter; they may, indeed, be drier at one season than another, but the abundant vegetation observed is the proof and the result of rarely ceasing rain. Thus the Nile combines the sources of supply elsewhere distinct. It is fed by the perpetual tropical rains, but it is fed also by the perpetual melting of mountain snow. It receives perpetual contributions from the south and west, and perennial tribute from the east; and this rush of water, increased at certain seasons, is, as it were, kept up from point to point along its course in the great swampy flats, as well as in the numerous lakes. As other streams originate in springs or glaciers—as some rush forth from the earth ready formed—so the Nile originates in lakes

and swamps, from which it emerges wide, rapid, deep, and navigable. For hundreds of miles all the additions it receives, and they are many and important, seem to do no more than keep it as it was. It remains large and full, but nowhere increases greatly in width, or rapidity of course or depth. After the largest affluents have combined their waters with the main stream there is still little difference. After the longest and most exhausting seasons of drought and incessant evaporation from a large surface in a burning climate, the Nile is still full, and often then begins its mysterious and periodic rise. This great mystery of geography, this miracle of Egypt from the earliest occupation of the country to this day, is thus seen to be the result of many circumstances, combining to ensure not only a perpetual water supply, but the required periodical flood at the exact season when it is most useful and least to be expected.

The general outline of the present great discovery of Captain Speke was certainly more than suggested, both by ancient and modern geographers—among the former by Ptolemy, and among the latter by Dr. Beke. So long ago as in 1846, the latter traveller, in a memoir read before the meeting of the British Association for that year, "inferred that the head of the Nile is most probably situated in about 2° S. lat. and 34° E. long., at the extreme eastern edge of the table land of Eastern Africa, and at a distance of 300 or 400 miles from the island of Zanzibar." This is the actual position of the Lake Victoria Nyanza. At the same time Dr. Beke suggested that "there is a third great arm of the Nile, namely, the Bahr-el-Ghazal, which joins the central from the west." The extreme probability of this, and the fact that this arm still remains to be explored, add interest to this opinion, expressed long before the commencement of those expeditions that have had so glorious a result.

It must not be forgotten, in concluding this notice, that the much disputed question of the existence of a group of mountains, called the Mountains of the Moon, again comes before us. Ptolemy, and since his time a multitude of geographers, have placed this supposed range in an east and west direction across Africa, to cross the direction of the Nile at right angles. Instead of this the chain, if it exists, is in a very different direction, is much shorter than had been supposed, and is probably much loftier. There are, however, two mountain chains that might be so called—one is the extremely lofty and snow-covered group, of which Kilmanjoro is the culminating summit; the other is the local range recently described by Captain Speke as occurring to the north of Tanganyika. Though much less lofty than the other moun-

tains, these latter are more nearly identical in position with the range formerly described. The question is, however, chiefly one of name, for there is little doubt that the really lofty mountains are grouped near Kilmanjoro, and are not far from the coast; while the high ground north of Tanganyika, though a water-shed, is by no means important in any other sense. That the existence of a chain separating the basin of the Nyanza from the basin of the Nile is absolutely disproved by Captain Speke, is a result of extreme interest, and also settles points that had been long disputed. It still remains to decide whether, according to Captain Burton, "an elevated mass of granite and sandstone crosses from the shores of the Indian Ocean to the centre of tropical Africa;" for this is of course possible, although it does not, as Captain Burton supposed, exclude Nyanza from the drainage basin of the Nile.

We now await the last stage in the discovery of the sources of the Nile. It is still possible that, far away towards the centre of the continent, there are waters that run eastwards to supply the great river, but it is certain that so far as the east and south are concerned the limits are determined. Whether Consul Petherick's party, or Madame Tinne and her suite, will be the next to give us information it is not easy to say. Both parties are busily engaged in the same work, and the result, whatever it may be, will be looked for with extreme interest by the civilized world. Meanwhile Captain Speke has worthily and well carried out and completed the task he had so boldly set himself.

CLUSTERS OF STARS AND NEBULÆ.—THE SURFACE OF THE MOON.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Our recent survey, in these pages, of the more conspicuous and interesting of the double and binary stars will, it may be hoped, have led the astronomical inquirer to wish for a still more extended knowledge of that glorious host of suns which surrounds him in every direction. It will be our object to give him such further assistance as we can in this noble pursuit, and therefore, quitting for the present the branch of study which has hitherto occupied us, we will choose a fresh point of view, and proceed to the consideration of other and more complicated arrangements.

It is impossible to look upon the open heavens without an instinctive conviction of the unequal distribution of the stars in space; some regions are left comparatively vacant; in others, there is a crowding together of stars so nearly corresponding in magnitude as to leave no doubt as to their actual combination in groups; the individuals of which may possibly be separated by distances baffling all human conception, but which yet show mutual connection as compared with the void space surrounding them. Of course a similar appearance would be the result, if they had only an optical and not a real proximity, being merely arranged nearly in the same direction with regard to our sight. But in order to produce this effect, there would necessarily be so strange a counterbalancing of distance and brightness, that we perceive at once the improbability of such an explanation. There are, no doubt, occasional instances of apparent equality resulting from such compensations of remoteness by superior brilliancy, because amid the profusion of the heavens there is room for every alternative; and, as it has been truly observed, an event, against the probability of which there are 10,000 chances to one, will yet actually occur, if it has 10,000 chances given to it. But still we shall be quite safe in concluding that such instances of apparent proximity are not the rule but the exception, and that in the case of large aggregations such an exception will approach impossibility. It may be very possible with regard to any two equal and adjacent stars, that their apparent neighbourhood may be a deception, from the compensation of brightness by distance; but the probability of such an arrangement will be much less where three are concerned, and will very rapidly diminish with increasing numbers. The evidence of sense is fully in accordance with this unquestionable deduction. We cannot look upon the three well-known stars in the belt of Orion without a dis-

tinct impression that they are all nearly at an equal distance from us; the same is the case with the seven of the Great Bear, and especially with the little constellation Delphinus, easily recognized during the evenings of the present season at some height in the southern sky, to the left of the brilliant Al Tair. No principle of perspective could be reasonably called in to account for the aggregation of so many stars of nearly similar magnitude within so small an area. Other instances might be given of groups, as such associations of stars may be properly called, visible to the naked eye; but it is in the expanded range of the telescope that they become more universally apparent. There we shall frequently meet with fields characterized by the prevalence of stars of a certain size, and where the evidence of actual vicinity, and oftentimes of very remarkable arrangement, is too obvious to be overlooked. These "groups," however,—adopting the accurate classification of Sir W. Herschel, who thus designates compressed collections of stars without central condensation, but forming insulated systems,—present only the simplest form of combination. In the continuance of our researches, and especially if we progressively increase the light of our telescopes, so as to penetrate further into the depth of the heavens, we shall discover a regular series of these aggregations. Groups will come into view not only more rich in numbers, but more thronged by the real or apparent nearness of their individual components; we shall not only notice a tendency to condensation towards the centre of the mass, which may be, though to a very limited extent, the effect of perspective from the greater length of the central visual line, but we shall find, in many instances, a degree of internal compression which perspective is inadequate to explain; and thus we shall be obliged to infer a degree of mutual proximity in that region which we have no means of estimating, but which, upon any supposition, must lead to thoughts of wonder as to the general structure of the mass. Such an assemblage, if its general outline were circular, as is frequently the case, would no longer be denominated a "group," but a "globular cluster," "clusters" being, according to Sir W. Herschel's definition, groups so arranged as to indicate the existence of a central force. To many of these most interesting objects we hope to direct our readers.

But we shall soon find that we are, practically at least, dealing with infinitude. Some of these clusters will exhibit their component stars with little difficulty in an ordinary telescope; in others, from the minuteness or the compression of their members—a natural result in either case of increased distance—we shall obtain a less perfect picture, and the general mass will assume a hazy aspect, though its real character will

be fully indicated by the sparkling points of light which mark the places of the brighter individuals, or, perhaps, the spots where two or three fall into the same line of sight. Such an object would be called an "imperfectly resolved nebula," a Latin word signifying fog, and well expressing the distinctive aspect of these bodies. Others, refusing to give up separately their component stars, present a mottled or granulated appearance, which the experienced observer well understands, and which enables him to class them as "resolvable nebulæ," that is, nebulæ which would, under other circumstances of distance or optical power, be resolved into stars. While lastly there are those, whose light is so *milky*, to use an epithet introduced by the elder Herschel, so uniform in its diffusion, as to mask completely their starry nature, and to render them "irresolvable." This remarkable and instructive progression cannot be adequately exemplified to the naked eye, because it so happens that we have no good specimen of a globular cluster sufficiently near to us to form the first step in the scale by its sensible resolution; but every telescope of sufficient power to resolve fairly the nearer clusters exhibits a series of this kind, passing from the group or cluster, which is a fully resolved nebula, to the irresolvable nebulosity which from analogy is, or may be, a group or cluster at an unapproachable distance; and each telescope has a series of its own, corresponding with its optical capacity; every increase of aperture, by its greater resolving power, increasing the number of groups and clusters at the expense of nebulæ, and yet so adding to the ranks of the latter by the addition of still fainter and more evanescent objects, that the sum total still goes on progressing, as though it were actually illimitable. Many an aggregation which appears but as a dim and hazy speck in our smaller telescopes, is wholly disentangled into separate stars by the reflectors of the Earl of Rosse, or Lassell, or Chacornac, or by achromatics such as those of Clark, or Bond, or Struve, or Secchi; while these again convert the "milky" into the "resolvable" nebulæ, and draw out of the unknown depths of space yet further, and obscurer, and previously imperceptible evidences of the incomprehensible magnitude of this great and wonderful universe.

Such is a broad and simple view of this grand subject. Whether this apparent simplicity is founded in the truth of nature, or whether it may prove one of those premature generalizations which only obstruct the path while they seem to clear it, need not be discussed at the present time, though it will ultimately come before us. But it is desirable, before proceeding further, to obviate any misconception which might arise from this mode of statement. We must bear in mind that our two assumptions, of sphericity of form in the mass, and

similarity of magnitude in the individuals, are only partially applicable. The forms of clusters and nebulæ are indefinitely varied; many being elliptical, a few spiral, others perforated, others again extended in length, branching, or contorted in various figures, while their components are by no means always all equally bright, the reverse frequently opposing a difficulty in the way of complete resolution, when the telescope can master the more resolvable portion, but leaves the smaller individuals merged in a general haze. In another respect, too, our statement requires qualification. It has been asserted that the apparent minuteness of the individual stars in certain clusters, as compared with others, may be the result of increased distance from the spectator, and the series which we have imagined is based upon this idea. It was that of Sir W. Herschel, who thus assigned the probable distances of nebulæ, in progressive remoteness, till they passed even beyond the space-penetrating power of his forty-feet reflector, which he estimated one hundred and ninety-two times greater than that of the eye —a value corresponding to three hundred thousand times the distance of Sirius! But this magnificent conception has been entirely overthrown by more recent discoveries. It rested upon the assumption that the distances of the stars are, on an average, in the inverse ratio of their apparent magnitudes—an assumption not merely recommended by its simplicity and facility, but by its being probably the only one whose adoption could lead to any positive or numerical result. Of late years, however, its inadequacy has become more and more evident, upon grounds so lately stated in the present publication (INTELLECTUAL OBSERVER, xviii. 454), that they need not be repeated here; and now it must be admitted that after so many years we find ourselves without a guide in the interminable wilderness of nebulæ. It is very possible that Sir W. Herschel's hypothesis may yet be correct as regards the majority of these objects, and it is unquestionably supported by the evidence of sense; but how deceptive this is has been demonstrated in the case of insulated stars and systems, and analogy has begun to lead us in an opposite direction. Analogy, with all its deficiencies, is like the one-eyed man, who has been said to be a king in the country of the blind; and reasoning from its indications where no others are attainable, we should have to conclude that the brightest and most resolvable clusters may be possibly as distant from us as some of those little heaps of "star-dust," whose aspect would bespeak for them a far more inconceivable remoteness, and that certain, again, of these latter may be even nearer to our system than some of those great and conspicuous stars, beyond which they were formerly placed at an immeasurable distance. In fact, whatever may appear pro-

bable, nothing is, nothing can be, proved as to the relative position of nebulæ in space, without a determination of parallax, which the want of precision in their boundaries renders peculiarly difficult, if it should ever be possible.

Few of the nebulæ, or clusters, which an astronomer would designate by that title, are visible to the naked eye. The Coma Berenices and the Pleiades are undoubtedly groups which, removed to increasing distances, would gradually put on the appearance of telescopic clusters, resolvable, and at length milky nebulæ. Several other groups or clusters were classed by the ancients as "nebulous stars." Ptolemy, who wrote about A.D. 140, mentions five—the grand cluster in the hand of Perseus; Præsepe (see Double Star list, No. 5), "the manger," lying between two small stars, called in those days "Aselli," the little asses—incongruous appellations, the general acceptation of which it is not easy to understand; a group near Scorpio; another in the eye of Sagittarius; and one in the head of Orion (Double Star list, No. 99). But objects of this kind would give way at once upon the first application even of primitive telescopes, and thus Galileo readily perceived and delineated twenty-one stars in the head of Orion, and thirty-six in Præsepe. In addition to these, and two or three lying too far south to be visible in our latitudes, we may enumerate the great nebulæ in the sword of Orion, and in the girdle of Andromeda—neither of them, singularly enough, referred to by the ancients, or even by Galileo—a minute speck in Hercules, and another in Gemini, and we shall have pretty fairly exhausted the list as far as the unaided eye is concerned; though it is not improbable that, under very favourable circumstances, a few more of the larger clusters might be made out, as spots of evanescent faintness. The telescope, of course, would immediately enlarge the catalogue; yet this did not take place as rapidly as might have been expected. Halley picked up a few; La Caille added to the number; but the French observer, Messier, who was called the "Comet-ferret," from his unparalleled diligence in searching for those visitants, and was thus naturally led to notice every object of a similar appearance, formed a much more extensive list, comprising, with those already known, one hundred and three nebulæ. This was published in 1783, to be superseded, three years afterwards, by the labours of Sir W. Herschel. He had already attacked the subject in 1774, and the extraordinary and previously unattained "space-penetrating" power—to use his own word—of his great reflectors, together with the unwearied diligence with which he swept the heavens, enabled him to produce, in 1786, a catalogue of one thousand clusters and nebulæ; in 1789, a second quite as numerous; and in 1802, another comprising five hundred more.

The worthy inheritor of his name and talent observed, between 1825 and 1833, no less than two thousand five hundred, of which five hundred were discovered by himself; and his catalogue, published in the *Philosophical Transactions* for the latter year, is still the standard authority upon the general subject; the subsequent most memorable researches of the Earl of Rosse, with some important observations by Secchi and others, relating only to select objects. Very recently, however, the observatory of Copenhagen having been provided with a magnificent achromatic by Merz, of about eleven English inches aperture and sixteen feet focus, Professor D'Arrest, the director, commenced, in 1861, a general revision of all the nebulæ visible in that latitude—a noble enterprise, to which every lover of astronomy will cordially wish eminent success. The rank of his telescope he estimates exactly at a medium between Sir J. Herschel's of 18¼ inches, and Lassell's of 24 inches; it shows all the nebulæ of the former, and had even detected, during 8 months, 100, out of 776, decidedly unknown before. He finds that the nebulæ of the two Herschels, where their observations were sufficiently detailed and repeated, are nearly all unchanged; and he thinks we shall never discover more than a few variable nebulæ: the difference of brightness now discernible in a large proportion of Sir W. Herschel's objects being referred by him to an insensible alteration in the estimate formed by that great observer. The material upon his hands, he says, grows beyond all expectation; but the study is beset with much difficulty and uncertainty, and he thinks it not much more advanced, even now, than the knowledge of insulated stars was in the days of Tycho, or at the commencement of Flamsteed's labours. His observations on double nebulæ, including in that term those within a limit of 5′ of arc, are most interesting. He had, up to May, 1862, recorded 50, and thinks their whole number may be about 300 among the 3000 of the general list. Their physical connection as binary systems, already suggested by Sir J. Herschel, he considers unquestionable: the mere aspect proves it abundantly, especially when some unusual form characterizes each object; and in future times the computation of the orbits of such systems will doubtless become matter of inquiry. He points out, but as a mere indication, a double nebula, whose distance was given by Sir W. Herschel in 1785 = 60″; by his son in 1827 = 45″, with a position-angle = 45°; and by D'Arrest in 1862 = 28″ and 56° 32′. Like all other observers, except those at Poulkowa, he testifies to the entire disappearance of Hind's wonderful nebula in Taurus (see INTELLECTUAL OBSERVER, iii. 244); but he considers doubtful a similar occurrence stated by Sir J. Herschel to have taken place in Coma Berenices, on account of the great

difficulty in identifying Herschel I.'s nebulæ in this region. He questions also the variation of another nebula mentioned by Schmidt. Three, however, of Sir W. Herschel's nebulæ—two of them of his first or brighter class, the other of his second—he has failed to find. The proper motion, which has been suspected by some astronomers in nebulæ, he thinks improbable. From time to time we hope to be favoured with further accounts of his progress in his most difficult, but most valuable and interesting, undertaking.

No objects (if we except comets, to which they often bear a curious resemblance) are more benefited than nebulæ by an increase of optical light. This is a natural result of the faintness and haziness which is their usual characteristic; and for their mere discovery or recognition, defining power is of less importance than breadth of aperture. When, however, the attempt is made to detect their starry composition, accurate definition resumes its usual supremacy; and increase of power is here important, as tending, by separating the minute points of light, to draw them out of the general haze. At the same time the want of contrast with the open sky attendant upon the contracted field of a high power is a serious disadvantage, and deep magnifiers should only be employed after the eye has become familiar with the object in the use of low and progressively increasing powers. The brighter nebulæ may be seen with so small an instrument that it seems singular that so few of them were noticed before the time of Messier. They are often perceptible enough in the fields of our finders. With an object glass of only 1¼ inch, in youthful days, I made out, undoubtingly, though of course dimly, several of these objects, and could have seen more had I known where to look for them. An object glass of $3\frac{7}{10}$ inches showed a great number very satisfactorily; and with 5½ inches the brighter clusters are beautifully developed. They require, of course, from the minuteness of their components, a darker sky than the majority of the double stars included in our list, and in haze, twilight, or moonlight, the search would be to little purpose. A popular catalogue of the more remarkable of these interesting objects will shortly follow.

THE SURFACE OF THE MOON.

In reverting to this subject, which has now, from the pressure of other interesting matter, been intermitted for a considerable time, we would point out to the inexperienced observer that, although, in mastering the difficulties which have been already indicated as existing in the accurate study and delineation of the surface of the moon, he will have advanced very far towards the attainment of his object, there still remains a source of perplexity, which will not indeed cause

him much embarrassment if he merely wishes, as is usually the case, to obtain a good knowledge or satisfactory drawings of lunar outline or relief, but which ought, nevertheless, to be clearly understood and taken into account. It would form of itself a most interesting investigation, and one as to which, at present, not much seems to have been done; and it is to be hoped that it may be taken up as a distinct but very important branch of selenography by some out of the many amateurs who are now directing telescopes of abundant competency towards our satellite. We are referring to the very remarkable effect of the different reflective power of different portions of the lunar surface. This, of course, is perfectly developed in the full moon, when, from the coincidence of the direction of vision with that of illumination, all true shadows disappear, and the circular disc, if homogeneous in its nature, would be overspread with an unvaried brightness, instead of that strange intermingling of clouds and stains and streaks and patches of light and darkness which is visible in some measure to the naked eye, and is so peculiarly unintelligible in the fuller revelation of the telescope.

There can be no doubt that the cause of all this variety is to be sought in the local colour of the surface, whose tints, however diversified, would naturally, at that distance, be so blended and confused as to assume the appearance of different shades of grey; but it is not so easy to comprehend the singular manner of their disposition, and it would be a curious inquiry how far any terrestrial analogy would help us towards an explanation. It is probable that, in some respects, our own lands, if viewed from the moon, would present an aspect not very dissimilar. The variegated hues of our familiar landscapes, the red tint of many soils under the plough, the green of our meadows and woods, and the yellow of our ripe corn, would not be separately recognized from their small angular extent, but would produce by their intermixture a neutral tint of varying degrees of intensity in different places; and if it should be objected that where the masses of colour are sufficiently extensive their separate existence ought to be recognized, and that we cannot suppose any difference beyond that of brightness between the aspect of the sands of Sahara and the forests of Brazil, it may be replied that some such indications of widely-spread local hues have actually been traced in the moon by Beer and Mädler, and that Piazzi Smyth was obliged to have recourse to colour to give sufficient likeness to his spirited sketches, at first attempted in one uniform tint. But this would still leave unexplained much that the student will soon find to be very strange in the disposition of the lunar lights and shades, and especially in connection with the forms

which they overspread and frequently obliterate. Some general rules may be traced, but exceptions are numerous and unaccountable; and while on the earth a similarity of structure and composition in neighbouring objects would be in all probability attended with similarity of colour, this is so far from being universally true in the full moon, that it is no uncommon thing to see one of two adjacent and resembling craters or ridges conspicuous at that time for its brightness, while the other shows scarcely a trace of its existence. This interesting subject will come before us again in detail; it is only adverted to in this place as occasioning some preliminary obstacles to the student in regard to the identification of many of the lunar spots, which from this cause becomes perplexing and uncertain, in proportion as the relief of the surface gradually disappears with the increasing angle of illumination.

Difficulties, if such there be, arising from the supposed varying conditions of the lunar atmosphere, will present themselves as matters of local inquiry.

In addition to the statement respecting the apparent dichotomy of Venus in p. 455 of the last number of the INTELLECTUAL OBSERVER, it may be remarked that the same phenomenon of disagreement with calculation was observed by De-Vico and his associates at Rome in 1839, the terminator becoming sensibly straight three days after the time specified in the tables.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*June* 17.

ON THE TERTIARY SHELLS AND CORALS OF JAMAICA.—Mr. J. Carrick Moore communicated the result of an examination of 71 species of Tertiary Mollusca from Jamaica, mostly collected by the late Mr. Barrett, showing that 12 are still living, and that 28 are common to the Tertiary beds of Jamaica and St. Domingo. The same relation between those deposits had been found to exist by Dr. Duncan through a comparison of the Corals. The "Pacific" affinity of many of these Shells and Corals was noticed as confirmatory of a conclusion arrived at by the author in a former paper; and it was shown, from the occurrence of Tertiary beds on the Panama Isthmus at a height of 250 feet above the sea, that the complete separation of the Atlantic and Pacific Oceans did not take place until after the commencement of the Tertiary period.

LINNÆAN SOCIETY.—*June* 18.

CINCHONA BARK FROM INDIA.—The gradual, but certain destruction of the Cinchona forests of America, which has been viewed with so much anxiety by all who know how indispensable quinine is to the existence of Europeans in many of the tropical parts of the world, has lost its importance by the successful cultivation of the Cinchonas in India. At the meeting of the Linnæan Society, June 18, Mr. Howard exhibited the first specimens of Cinchona bark sent from India. It was stated that these had been found to yield a per centage of quinine, and the other febrifuge alkaloids, fully equal to that furnished by the bark of the same species when grown in South America. Mr. Howard also stated that quinine might be obtained in small quantities from the leaves. The successful culture of the Cinchona plants in India must be regarded as a subject of the highest importance, not merely to the prosperity of India, but indirectly to the whole world. The exploration and civilization of many tropical countries by Europeans being absolutely dependent on a supply of quinine.

CHEMICAL SOCIETY.—*June* 4.

SYNTHESIS.—M. Marcellin Berthelot, of Paris, gave a lecture to the members of this society "On Synthetic Methods in Organic Chemistry." It was an able *résumé* of the chief steps by which complex organic substances have been built up from the elements carbon, hydrogen, oxygen, and nitrogen. Although no absolutely

new facts were given, yet the treatment of the subject was such as to present some of the phenomena in a new light. It was illustrated by several experiments; the most interesting among these showed the first and most important synthetic step—the direct combination of carbon and hydrogen with formation of acetylene, $C_4 H_2$. The union was thus accomplished: A stream of hydrogen was conducted into a globe, in which the electric arc was shown between two carbon poles. The particles of carbon, transferred mechanically from one pole to the other, took no part in the chemical action, but the volatilized carbon combined, in the intense heat, with the hydrogen present. The acetylene thus produced was converted into a compound with copper; from this substance olefiant gas was prepared, and, finally, from olefiant gas, alcohol.

GEOGRAPHICAL SOCIETY.

On the Flora and Fauna of the Malay Archipelago.—Mr. Wallace's paper on the above subject was read by the secretary. The Malay Archipelago was stated to be an island region of continental dimensions and importance. Its varieties of surface, of geological structure, of climate, of animals and vegetables, and of races of mankind, are equally great with those of some of the primary divisions of the earth. The chief contrasts the islands present were then dwelt upon; volcanic and non-volcanic districts, forest regions and open plains, regular and irregular seasons, and, lastly, the Indo-Malayan and Austro-Malayan divisions. In treating of this last subject it was shown that the Archipelago was naturally divisible into two districts—the western, comprising the islands of Java, Sumatra, Borneo, and the Philippines, resembling the Asiatic continent in its animal productions; while the eastern, including all the other islands as far as New Guinea and the Solomon Islands, possessed all the chief geological characteristics of Australia. Corresponding to these divisions a physical peculiarity was shown to exist—namely, that the western islands were all united by a very shallow sea to South-Eastern Asia, while New Guinea was in like manner united to Australia. Asia and Australia were known to be more widely distinct in their animal and vegetable productions than any two portions of the earth; and it was shown that their peculiarities extended on each side into the adjacent islands, so that when you came to the little islands of Baly and Lombock, separated only by a strait fifteen miles wide, you had the productions of two continents brought into close contact without intermingling, the birds for example being almost totally different in the two islands, and not the species merely, but even the genera and families of the one not extending into the other.

NOTES AND MEMORANDA.

MR. GLAISHER'S ASCENTS.—The eleventh took place from Wolverton on June 26th at 1.3 p.m. The chief results are given in the following paragraph, written by himself. He says:—"This ascent must rank amongst the most extraordinary ever made. The results were most unexpected. We met with at least three distinct layers of cloud, on ascending, of different thicknesses, reaching up to four miles high, when here the atmosphere, instead of being light and clear as it has always been in preceding ascents, was thick and misty; but perhaps the most extraordinary and unexpected result in the month of June was meeting with snow and crystals of ice in the atmosphere at the height of three miles, and of nearly one mile in thickness."

The twelfth ascent took place on the 11th July. The balloon passed over Sussex and the currents of air were remarkable, the stratum moving from the N. being in contact with that from E. Mr. Glashier finds the velocity of air currents measured from balloon heights to be very much greater than what is shown by terrestrial instruments. He says, "The difference between the two is so large that it seems scarcely to be accounted for by the undulatory nature of the surface of the earth, and implies that our hitherto estimated velocities of wind are erroneous." Clouds were found four miles high, "when the temperature of the dew point must be some degrees below zero." This, with similar facts in a previous ascent, implies the presence of very little water; "yet," we are told, "there was enough in both cases not only to be very visible, but to exclude everything beyond them. This fact is important, and indicates that our theory of vapour must be reconsidered."

The thirteenth ascent was from the Crystal Palace on the 21st July, and afforded reason for believing that when rain falls from an overcast sky there is a second cloud stratum above.

AMŒBÆ, *princeps and villosa*.—Mr. H. J. Carter states in *Annals of Natural History* that he has often found villous appendages to the *A. princeps*, which confirms Dr. Wallich's opinion that *villosa* is not a distinct species, although it may be convenient to give it a separate name.

INSTINCT IN INFUSORIA.—Mr. Carter mentions in the paper from which the preceding remark is taken that he watched an Actinophorus Rhizopod extracting starch grains from a ruptured cell looking like a spore; the creature then retired some distance off, and then returned, and although no more starch grains were protruding, he contrived to extract some from the interior. "This," he says, "was repeated several times, showing that the Actinophys instinctively knew that these were nutritious grains, and that they were contained in this cell, and that although each time, after incepting a grain, it went away to some distance, it knew how to find its way back." He likewise mentions the cunning of an Amœba, which crawled up the stem of an acineta, and placed itself round the ovarian aperture, so as to receive an infant as soon as it was born. He observes that "these facts evince an amount of instinct and determination of purpose which could hardly have been anticipated in a being so low in the scale of organic development."

ABSENCE OF SUN SPOTS.—On the 5th July, the Photoheliograph at the Kew Observatory—which, it may be interesting to know, is worked by a very intelligent young woman, the daughter of an artizan—afforded a sun picture without a single spot. As we are now in the descending curve of the periodical variation in the quantity of these spots, and approaching the minimum, it will be important to learn how often they are totally absent. The Kew observations may be expected to throw much light upon the connection between these spots, and disturbances in terrestrial magnetism.

THE GASSIOT SPECTROSCOPE.—This splendid instrument, constructed by Mr. Browning, is now at the British Association Observatory, at Kew, in order to

carry out the munificent intention of Mr. Gassiot, who gave the order for its construction, for the purpose of placing the finest possible means of spectroscope inquiry at the disposal of the cultivators of this branch of science. The instrument is furnished with nine exquisitely-finished prisms, possessing in the aggregate a very high dispersive power. The telescopes attached to it are two feet long, supplied with numerous eye-pieces and every appliance to facilitate delicate and difficult investigations. For any ordinary purpose, a less costly and complicated spectroscope is amply sufficient, and the famous researches of Kirchhoff and Bünsen were made with very inferior means. In able hands we cannot doubt that the Gassiot spectroscope will add an important chapter to the revelations of light, and it must be regarded as a noble instance of judicious generosity on the part of an esteemed and successful cultivator of physical science, and of exquisite skill as an optician on the part of Mr. Browning, to whom the credit of the construction is entirely due.

The Patent Achromatic Binocular Magnifier.—Having received from Messrs. Smith, Beck, and Beck a case of the instruments described under this lengthy title, and having employed them for many purposes, we can testify to their great superiority over the simple lenses they are intended to replace. They are composed of an achromatic combination on the binocular principle, but the lenses are so cut that the effect is like employing the centre only of an ordinary lens, and the angle is so arranged that the eye looks naturally through them, without any of the squinting or straining which makes ordinary magnifiers fatiguing and unsatisfactory. They are of three sizes, having focal lengths of seven, five, and three inches respectively, and can be used as hand magnifiers, attached to a neat handle, or mounted upon a novel and ingeniously-devised stand, which possesses a multiplicity of motions, and enables a very accurate adjustment to be made. We have tried them for viewing photographs, for microscopic dissection, and for looking into bottles and aquaria, and in each case have had reason to be satisfied with the facility and accuracy of their performance.

Structure of Blood Corpuscles.—Dr. William Roberts, of Manchester, has communicated to the Royal Society an account of experiments with human blood corpuscles, and those of other vertebrate animals. The reagents he employed were a solution of nitrate of rosanilin (magenta), prepared by making a nearly saturated solution by boiling the salt in water, filtering after twenty-four hours, and then slightly diluting it, and a solution of tannin, three grains to the ounce of water. A speck of human blood was mixed with a drop of the magenta solution on a glass slide; the corpuscles became transparent, and of a faint rose colour; they expanded sensibly, lost their bi-concave figure, and a dark red spot made its appearance on some portion of their periphery. When the blood of the oviparous vertebrates was employed, the central nucleus came fully into view, and assumed a deep blood-red colour; the oval form of the corpuscles was lost, and a dark-red spot appeared on their periphery. Tannin caused the corpuscles to bud or pullulate; one drop of blood mixed in a conical glass, with four or five of the solution, generally answered perfectly. The pullulations were easily seen under the microscope, by placing a drop of the tannin solution beneath the covering glass, and permitting a little blood to insinuate itself under it. The pullulations appeared organically connected with the corpuscles, but to form no part of their cavity. Dr. Roberts concludes from his researches that the mammalian corpuscles are homologous, as wholes, with those of the ovipara, and not with its nucleus, as supposed by Wharton Jones; and that the envelope of the blood disk is a duplicate membrane; in other words, that within the outer covering there exists an interior vesicle, which encloses the coloured contents, and in the ovipara the nucleus. He observes that Dr. Hensen, of Kiel, had attributed this structure to the blood corpuscle of the frog, and that in this view the blood corpuscle is anatomically analogous to a vegetable cell, and the inner vesicle corresponds to the primordial utricle. Further details will be found in *Proceedings of the Royal Society*, No. 44.

HORNED PHEASANTS.—MALES AND FEMALE.

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THE INTELLECTUAL OBSERVER.

SEPTEMBER, 1868.

REMARKS UPON THE HORNED TRAGOPANS (CERIORNIS SATYRA).

BY A. D. BARTLETT,

Superintendent of the Zoological Gardens, Regent's Park.

(With a Coloured Plate.)

Of this fine group of birds there are four well-known species; it may, however, be said that the most beautiful species is the one above named, and the subject of these remarks. This species is found in *Nepal, Sikhim,* and *Bootan,* in other words, the Eastern Himalayas, while the next species in point of beauty (*Ceriornis Hastingsii*) inhabits the Western Himalayas. Both species are indiscriminately called Argus pheasants by Indian sportsmen, which name, however, really belongs to a totally different bird, which is found in *Malacca,* and certainly has never been met with near the Himalayas.

The great difficulty in obtaining and bringing living examples of these birds to Europe has been well-known to all collectors whose previous efforts have failed, and only two recorded instances are known of these birds having reached England alive. Upon the first occasion one male only of *Tragopan Temninkii* arrived, and upwards of twenty years passed before a second bird of this group made its appearance. In 1857 a *female* of *Ceriornis Hastingsii* was brought home by Mr. Thompson, who was sent to India by the Zoological Society to receive and bring home a collection of these and other game birds that had been collected for the society, and also for her Majesty the Queen. Since the above date no others have reached this country until the 31st March in the present year; on that day *nine* fine and healthy birds arrived—these were *six males* and *three females* (as before stated of the species know as *Ceriornis Satyra*).

We are indebted to the zeal, ability, and persevering

energy of Mr. John J. Stone, assisted by the Rev. W. Smyth, and the Baboo Regrendra Mullick, for obtaining and forwarding these birds to England. The trouble and expense attending the importation has hitherto prevented many from making the attempt—the above-named gentlemen did not allow these considerations to stand in the way; hence we have for the first time the opportunity of seeing these magnificent birds in all their glory. Notwithstanding the long voyage, the birds had been so well attended, and every care bestowed upon them, that almost as soon as they were liberated from the coops in which they arrived they began to show signs of breeding, and we have now the gratification of being able to say that two small broods have been hatched, and several eggs are now in the process of incubation, showing at least that these birds are easily adapted to their changed condition, and also that they are very likely soon to be acclimatized. It is quite impossible to convey in writing or drawing a very perfect idea of the extraordinary beauty of the living *male bird* during the short and almost momentary display he makes while courting the female, on account of the vibratory motion of the head and neck, which, of course, render a drawing imperfect, and it is next to impossible to describe these parts and the appearance of the bird in rapid motion. It is therefore necessary, in order to understand it fully, that it must be seen.

We have reason to believe that these birds are monogamus, resembling the partridge in this respect; the eggs, however, bear a close resemblance to those of the wood grouse (*Capercaillie*), and the young birds when newly hatched are not unlike the chicks of that bird. The wings of these chicks are sufficiently developed as soon as they are hatched to enable them to mount to the branches of trees or shrubs, much like the habits of the tree grouse.

In size the *young Tragopan* equals a chick of the largest Cochin China fowl (when first hatched); its colour is rufous brown, slightly mottled on the back, the wings are marked much like the wings of the female gold pheasant. It is impossible to avoid thinking of the large tree grouse (*Capercaillie*) when examining these birds; the egg and young, as before stated, strongly resemble, and the habits also of the adult birds, we are told, are very similar; for instance, they *frequent the lofty trees in the pine forests* in the Himalayan mountains; they are capable of bearing any amount of cold, feed on berries and tender shoots of plants, etc., etc. Their flesh is excellent, therefore this bird appears to be one of the most desirable to introduce, not only on account of its brilliant colour, and its charming markings, but as a great addition to our table luxuries. It is doubtless a very prolific breeder, and in all probability, if

once established in the northern parts of Great Britain, would multiply rapidly.

The experiment thus far appears successful, and in every way encouraging. Who knows what may yet be accomplished when we call to mind the gaudy *peacock* originally brought from the *hot plains of India,* and now bred and kept in perfect condition in all his native beauty in almost every place in *Europe* and *America!* Look again at the *guinea fowl,* brought from the hottest parts of Africa, living and breeding wherever it has been introduced, almost like a wild bird. Many other instances could be pointed out if necessary to show what may be done if the proper means are used, and the right people set about it.

Mr. T. W. Wood furnishes the following notes from his own observations of these birds in captivity. "The male horned pheasants can only be seen to advantage in the early morning and in the evening, as they conceal themselves during the rest of the day; the females, however, are less retiring in their habits, one or two of them being generally visible at any hour of the day; this is also the case with two young males, which have not yet assumed their adult plumage. I have no doubt that in thus concealing themselves during the bright daylight, the adult male birds, in their wild state, escape the attacks of enemies, to which they must be much more liable than their companions, on account of their attractive colours.

"Knowing the birds of this genus to be furnished with ornamental fleshy appendages to their heads, the form and colours of which cannot be preserved after death, I was very anxious to observe them in the living subject. The two horns are situated about half an inch behind each eye; they are about one inch in length, and of a very clear and beautiful light blue colour, with a slight tinge of green in one of the specimens. When the bird is not excited, these horns lie perfectly concealed under two triangular patches of red feathers, their points meeting at the occiput. In addition to the horns, there is a large wattle, which is also concealed or displayed at the will of the bird; it is almost exactly of the shape and size of the human tongue, thin and free at the sides and end, the central part being capable of inflation. This portion, and the naked skin round the eyes, are of a pure ultramarine blue colour; the outer part on each side is deep red, of a tint between carmine and vermilion, upon which, proceeding from the central blue, are five pointed stripes of pure light blue, their points being directed outwards and slightly downwards; one of these stripes forms an edging to the basal portion of the wattle, the end of which is also broadly edged with the same light blue, which colour extends upwards for a short distance along the margin, and unites with the two lower blue bands at their ends.

"The male bird had three distinct modes of 'showing off' (if I may be allowed the expression), the most characteristic of which I have endeavoured to portray in the coloured plate. When this attitude is assumed, the bird, after walking about rather excitedly, places himself in front of the female in the next cage; the body is slightly crouching upon the legs, the tail bent downwards; the head is kept violently jerking downwards, and this causes the horns and wattle immediately to appear. The wings have a flapping motion, and the bright red patch on them is fully displayed. On one occasion I heard a loud tapping noise, as if a person near were knocking the railings with a small stick; it, however, proceeded from the bird, each movement of the wing being accompanied by a tap. I could not understand how this noise could have been produced, as the wings did not touch the ground, except, perhaps, at their extreme ends, which would not be sufficiently stiff to cause such a loud noise; this sound therefore is, no doubt, vocal. The whole of the neck appears to be larger than usual during this action, and also the horns, which vibrate with every movement. This wonderful display is concluded by the bird suddenly drawing himself up to his full height, with the wings expanded and quivering, the horns erect, and the wattle fully displayed.

"The bird courts the 'ladye love' in his own cage, very much after the same manner as the common pheasant (*Phasianus colchicus*), by simply erecting all his feathers and elevating one shoulder, thereby exposing a greater surface to view, without, however, showing his head-dress.

"The third mode of display is by simply standing boldly erect on an elevated perch, and giving the head one or two sudden shakes, when the horns and wattle appear for a few moments.

"The male horned pheasants have two or three distinct call notes; the one most frequently heard is much like the quacking of a duck; another is a loud and somewhat hoarse and plaintive cry, which is repeated at intervals of a few seconds, louder and louder each time. A third note is the "crowing," very different from that of the common pheasant, but accompanied by the same sudden and rapid fluttering of the wings as in that bird.

"I may add that the wattle is ordinarily contracted, and concealed by the feathers, no sign of it appearing. The display takes place chiefly, if not exclusively, during the breeding season, and even then it occurs but rarely; and a person who really means to see it must often wait an hour or two, and have a large stock of patience in store. The females are at least one quarter less in size than the opposite sex, and,

although quietly and soberly coloured, the markings of their plumage are exceedingly neat and beautiful. Their quiet browns and other tints must be necessary to their very existence when engaged in incubation and the rearing of their young brood. Both sexes have a habit of crouching close to the ground when alarmed, and in this position even the gorgeously-coloured male has a good chance of escaping observation, the colour of his upper parts being chiefly brown, mottled with black, with a few dashes of red, and having a round white spot at the tip of each feather. The tail is somewhat roof-like in shape, and consists of twenty blackish feathers, which are mottled with yellowish on their basal half. These, as well as the largest of the tail coverts, are remarkably plain when compared with the rest of his plumage; the largest coverts are brown, edged at the end with a lighter tint of the same, inside of which is a blackish line. These feathers are somewhat squared at their ends, which circumstance, together with their edging, reminds one strongly of the plumage of the turkey, to which bird the horned pheasants are nearly related.

"The breadth of the light blue stripes on the wattle varies considerably in individual specimens. The plumage also varies much in depth of colour."

SANDAL-WOOD AND ITS COMMERCIAL IMPORTANCE.

BY BERTHOLD SEEMANN, PH.D., F.L.S., F.R.G.S.

If all the sandal ever burnt before the shrines or used in the manufacture of idols could be piled in one heap, what a mountain it would be! The trade in this fragrant wood, still important, has been going on since the dawn of history, and will probably not cease until the connection between sandal trees and idolaters, existing from time immemorial, shall have been broken up by either the one or the other becoming as extinct a race as the Archyopteryx, the Moa, or the Dodo. The religious sentiment of millions of human beings is still intimately associated with this wood. When the Hindoo or Buddhist beholds its smoke, incense-like, gently curling heavenwards, he feels that he has acted up to the religious duties expected from him, and that the perfume, smelling sweetly in the nostrils of his deity, "will cover a multitude of sins," of which he may have been guilty. History fails to record why sandal was chosen for offices so important, but we may easily fill up the blank. Mankind in its infancy attributed to their gods all the passions, weaknesses, and predilections common

to men. Sandal-wood as a perfume was in high esteem throughout tropical Asia, and for people with so limited conceptions nothing was more natural than to suppose it acceptable to supreme beings having passions identical with those of the worshippers. Some of the most ancient records inform us of the prominent part played by the wood in India; and since the introduction of Buddhism into China, that country, itself destitute of the trees producing it, has become the principal market for this important production. The usual size preferred in the Celestial empire is of a diameter of four to six inches, and a length of three feet. A piece of these proportions (eight or twelve of which generally weighing one picul= 133 lb.) is regarded as the most acceptable offering a person can make to the idols of the temples. Large pieces are presented by the rich to burn on particular occasions. On certain festivals, for instance the beginning of the New Year, small pieces are abundantly sold in the streets to the lower classes. This is the case especially in the northern provinces of the empire; in Canton and other coast districts the population is less superstitious, and consequently less inclined to invest in sandal-wood. I visited a good many temples in Southern China, and never noticed whole pieces of the wood, but thousands of so-called "Joss-sticks," (pastile-like preparations, made of the saw-dust of sandal-wood and the dung of swine, stuck in pots of sand) burning slowly before the grave faces of the idols.

The perfume of the wood is owing to an essential oil, chiefly situated in the heart of the tree and near the root, the outer parts of old trunks and young trees being almost entirely without scent; hence, the sandal cutters carefully remove the outer and generally lighter portion of the wood, which they term the "sap." The oil is easily extracted, a pound of wood yielding about two drachms, and it is wonderfully strong and penetrating. Mixed with pure alcohol it forms the perfumer's "Extrait de bois de Santal," and in order to sweeten it for handkerchief use a slight addition of rose is required. It mixes well with soap. With charcoal and a little nitre it forms sandal pastiles for perfuming apartments; but these are indifferent in odour. Finally, from mixing favourably with otto of rose, it is often employed for adulterating that article. The seed of the *Santalum album* also yield by expression an oil, but that is thick and viscid, only fit for burning, and employed in that way by the poorer classes in India.

The chief European reputation of sandal rests upon its being a most excellent wood for carving. In the Indian collection of the Great Exhibition of 1862 there were an infinite variety of elaborately-worked card-cases, work-boxes, trays for

cards, walking-sticks, fly-flaps, and similar pieces of workmanship of it. The ancients seem to have been fully aware of this peculiarity, and the algum or almug trees which the fleets of Hiram and Solomon brought from Ophir, mentioned both in the first book of Kings (x. 11, 12) and the second of Chronicles (ix. 10, 11), never seen before that time in the land of Judah, and employed for making pillars and terraces for the temple and the king's house, and harps and psalteries for the singers, are supposed to have been sandal-trees. A more recent use has been prominently brought before the Indian public by Dr. Hunter, who has shown how admirably it is adapted for wood engravings. Some blocks yielded upwards of 20,000 impressions without being worn out. The dark-coloured wood, five inches in diameter, grown on rocky soil, is the best for the engravers' purpose. This has not been tried in England, as its price was thought to be too high, but on comparing it with box-wood, which sells in England for one penny the square inch, it was found to be cheaper in India than box-wood in England.

Sandal-wood is the produce of several species of *Santalum,* the type of the natural order *Santalaceæ,* and a genus composed of about twenty members, spread over Asia, Australia, and Polynesia, and best compared in aspect with myrtles. Indeed the Fiji islanders class their species of sandal-wood with the *Myrtaceæ,* and give it the same generic name. And they are not far wrong. Both have opposite leaves, furnished with oily dots, flowers similarly arranged, and an inferior ovary. But the genus *Santalum,* unlike *Myrtaceæ,* has no petals, only a tetramerous, seldom pentamerous calyx, which in most species is white, but gradually changes to pink, and ultimately becomes brown. Hence some authors have described these trees as bearing differently coloured flowers.

The most easterly species is *Santalum insulare,* found in the Marquesas islands and Tahiti, where it is know as "Eai;" the southernmost in New Zealand (*S. Cunninghamii*), known there as "Mairi;" the northernmost in the Sandwich Islands; and the most westerly (*S. album*) in the Indian peninsula. All the species delight in dry, rocky localities, hovering about the craters of extinct volcanoes and similar situations, and degenerating in quality, commercially speaking, when growing in moist places. The most barren islands in the South Sea are those yielding the finest sandal; and as in such islands provisions are scarce, and the natives much less amiable than where food is abundant, we shall see in the sequel how disastrous this peculiarity has proved for the white race.

Santalum album, and a marked variety of inferior quality, known as *myrtifolium,* grows on the mountains of continental India and the Indian Archipelago, Mysore, Malabar, and

Canara being the principal districts. The tree is usually twenty-five feet high, and when allowed to attain a greater height its trunk is generally found rotten at the core. The natives have an idea that the trees ought to be felled in the wane of the moon; an idea Europeans are wont to laugh at, though they might look a little more closely into the matter before doing so. I remember that in tropical America I often heard the wood-cutters declare it to be absolute folly to fell timber whilst the moon was on the increase, as it was sure to become rotten very

BRANCH OF SANTALUM ALBUM. (NAT. SIZE.)

soon, being then in full sap. The bark of the sandal-tree should be taken off immediately, and the trunks cut into billets two feet long. These should then be buried in a piece of dry ground for two months, during which time the white ants will eat away all the outer wood, without touching the heart, constituting the sandal of commerce; the billets ought then to be taken up and smoothed, and, according to their size, sorted into three kinds. The deeper the colour the higher is the perfume; and

hence the merchants sometimes divide sandal into red, yellow, and white; but these are all various shades of the same colour, and do not arise from any different species in the tree. The nearer the root, in general, the higher is the perfume; and care should be taken, by removing the earth, to cut as low as possible. The billets next to the root, when this has been done, are commonly called *root sandal.* In smoothing the billets, chips of the sandal are, of course cut off; so are also fragments in squaring their ends, both of which, with the smaller assortment of billets, answer best for the Arabian markets; and from them the essential oil is distilled, so much esteemed in Turkey. The larger billets are sent to China, and the middle-sized ones used in India. When thus sorted and prepared, the sandal, at least three or four months before it is sold, ought to be shut up from the rain and wind, in a close warehouse; and the longer it is kept, with such precautions, the better; its weight diminishing more than its smell. Prepared in this way, it rarely splits or warps, accidents which render it unfit for many of the purposes to which it is applied.

Sandal-wood is sometimes called in old English works "Sander's-wood," but our present form, "Sandal" (Arab. *Sandal*), is more correct; the Chinese term the wood collectively, "Tan-heong," *i. e.*, scented tree. On the Malabar coast, *Santalum album* is termed, "Chandana cotta," whilst the Polynesian species go by the generic name of "Ahi" (with various prefixes and affixes), which in Fijian becomes "Yasi;" in Eromangan, "Nassau," and in Tanna, "Nebissi," and reminding one of Ayasru, the name *Santalum album* bears in Amboyna.*

* Mr. E. Deutsch, of the British Museum, a distinguished oriental scholar, kindly forwarded the following reply to several questions which I put to him about the derivation, meaning, and nature of the various Asiatic names of the sandal-wood: "Sandal is termed 'Chandana' in Sanscrit, and is the name of the tree as well as its wood and the perfumes prepared from it. 'Chandana-chala is another name of the 'Malaya Mountain,' a part of the Southern Ghats, whence a great deal of sandal-wood is derived. The name does not imply fragrant wood or sweet wood.—The term 'Sandal' is Arabic, and also used in Hindustani; but does not seem to have any meaning save that of sandal-wood. That the Biblical Algum or Almug means sandal-wood is a mere recent conjecture. The Talmud identifies it, perhaps on account of the colour, with corals. Celsius believes it to be a spurious red sandal-wood (*Pterocarpus santalinus*), while the LXX. translate it πελεκητά, πεύκινα, and the Vulgate, Cina (Hyedar? African Arbor vitæ? or a kind of pine?). David Kimchi, a commentator of the twelfth century, regards it as the Arabic 'Al-Baccam' (almond-tree, *Cæsalpinia Sappan*, *Pterocarpus santalinus?*). But this, too, is mere guess-work. The word is not of Hebrew or even of Semitic origin, but seems to have been handed over by the Arabs, who probably derived it from India. Almug, however, somewhat reminds of the Sanscrit terms, 'Mocha,' 'Mochata,' which also signify sandal-wood. You may, however, rest satisfied that *nothing certain is known* about the foregoing terms. They seem as if dropped from the sky, and philologists would be obliged if you could throw any light on them."

Until the middle of the last century sandal was exclusively obtained from the East Indies, but after Captain Cook and his successors had made Europeans familiar with the chief features of the South Sea, enterprising traders went in search of the wood amongst the innumerable islands scattered over the broad Pacific like stars on the firmament. One of the first groups visited, chiefly by vessels from Manila, was Fiji or Viti. The sandal-wood of that group, confined to Bua bay on Vanua Levu, and derived from *Santalum Yasi*, a middle-sized tree, with lanceolate leaves, white ultimately brown flowers, and a fruit resembling a black currant, had long been famous in those waters, and induced the Tonga islanders to undertake regular trading voyages to the place where it grew, and even attempt to transplant the tree to Tonga; where, though it vegetated, the wood was found to be almost without scent. We are indebted to Mariner for an insight into this early intercourse. He tells us of a Tongan chief who had been abroad for fourteen years, and originally set out on a sandal-wood expedition to Fiji. Before iron tools and implements came in use, the Tonguese paid in bark-cloth, the *sting* of a fish used for spears, sail-mats, plats, and a rare ornamental shell peculiar to Vavau. They passed on portions of the wood to the Samoans, who, in common with themselves and the Fijians, grated the sandal-wood on the mushroom coral (*Fungia*) and used it for perfuming the cocoa-nut oil, so extensively applied by Polynesians for greasing their naked bodies. The white traders who first ventured to Fiji seem to have proceeded with great caution, and never commenced transacting business until chiefs of rank had been placed on board as hostages. Notwithstanding, several collisions between natives and whites are recorded. So great was the demand for the wood in both the Chinese and Polynesian markets that, about 1816, there was scarcely enough left for home consumption. In 1840 the United States Exploring Expedition with difficulty obtained a few specimens for the herbarium, and to save the tree from utter extinction the Rev. Mr. Williams planted one in the gardens of the Bua mission station, which enabled me to describe it botanically. At present fancy prices are readily given for the little sandal-wood now and then turning up, and a log about six feet long, presented to me in 1860, was thought a valuable gift by my native attendants.

About 1778 the attention of the commercial world was first drawn to the existence of sandal-wood in the Hawaiian or Sandwich Islands, and a Captain Kendrick, of a Boston brig, is known to have been the first who left two men on Kauai to contract for several cargoes. The natives term it "Lau ala" (*i. e.*, fragrant wood) or Iliahi, and distinguish two different

kinds—the Lau keokeo or white, and the Lau hulahula or red. Botanists have described four species of *Santalum* from this group (viz., *S. Freycinetianum, paniculatum, ellipticum,* and *pyrularium*), but *S. ellipticum* and *paniculatum* are supposed to be mere varieties of the first named, so that two species only remain, agreeing with the native classification. They are spread over Hawaii, Maui, Oahu, and Kauai, where they occupy stony, well-drained places. Of the magnificent groves that formerly covered parts of the islands, only a few isolated specimens now remain, and these would long ago have been converted into fuel had not the law thrown its protecting shield over them. When in 1849 I visited Oahu I saw merely a few bushes, not exceeding three feet in height, at a place called Kuaohe; but towards the end of last century and the beginning of this, the infant kingdom of Hawaii, then under the able government of the first Kamehameha, exported vast quantities of the wood; and without this profitable trade that king would probably not have succeeded in leading his people, in one generation, from extreme barbarism to nascent civilization. The sandal-wood was to these islanders the start in life, without which few nations or individuals ever succeed in pushing their way in the world. From 1790-1820 numerous vessels called for sandal-wood, bringing all sorts of good things in exchange; and about 1810 Kamehameha I. and his people began to accumulate considerable wealth. In one year near 400,000 dollars were realized. Kamehameha, hearing of the great profits derived from the sales in China, determined to send to Canton a ship of his own, laden with the produce. Extravagant port charges and the misconduct of the English captain and native supercargo led to the commercial failure of this enterprise. The king found himself 3000 dollars out of pocket by it; nevertheless he had the satisfaction of seeing for the first time his flag displayed in a foreign port, whilst the charges for pilotage, anchorage, and custom dues suggested to him the idea of raising a revenue from the same sources, and thus permanently benefit his dominions. Under the reign of his successor (Liholiho), the sandal-wood began to be exhausted, though in 1820 we still hear of 80,000 dollars worth of the wood being paid for the barge of the "Cleopatra," and in 1822 of a voyage to Kauai to collect the annual tribute of the wood in that island. But the produce became every day more difficult to procure, and could no longer be demanded in payment of taxes. True, quantities were now and then brought together, but they were insufficient to fill whole vessels as in times gone by. Nor did the discovery of a substitute, *Myoporum tenuifolium*, a tree from fifteen to twenty feet in height, with small leaves and white flowers, and a scented wood, revive the trade—the spurious sandal proving

useful only for planes. A new chance, however, seemed to present itself, and of this both chiefs and people eagerly availed themselves.

In November, 1829, a vessel arrived, from which it was learnt that in the South Pacific an island full of sandal-wood had been discovered. Its situation was confidently communicated to Boki, the governor of Oahu, who, delighted with a chance of retrieving his ruined credit, accepted the proposal to fit out an expedition for taking permanent possession of so rich a prize. Two men-of-war brigs, the "Kamehameha" and the "Becket," were selected for the purpose, and well provided with ammunition, arms, and stores for colonization. Nearly 500 people, including ten foreigners, embarked in these small vessels. All were going to make their fortune; and so great was the general infatuation that, in spite of the earnest remonstrances of the foreign residents, the expedition started. It first touched at Rotuma, north of Fiji, where discontent, from the hardships of the voyage, began to show itself, and where a number of the aborigines were pressed into the service of the already over-crowded vessels. The destination now turned out to be the island of Eromanga, and the "Kamehameha," having completed her preparations, sailed ten days in advance of her consort; but she was never heard of again. The "Becket" reached Eromango in safety, and remained for weeks, committing outrages on the natives, which led to frequent hostilities, and completely frustrated the object of the expedition. The "Kamehameha" not arriving, and a distemper breaking out, which carried off many of the company, including the commanding chief, the "Becket" resolved to return home. A scene of horror now ensued which baffles description. Crowded with the sick, the dying, and the dead, the vessel, slowly making her way through the sultry regions of the tropics, became a floating charnel-house. The sufferings of the survivors were aggravated by the want of water, food, and medicines. The course of the brig was tracked by corpses, and out of two hundred and twenty-six souls that comprised her company on leaving Rotuma, only twenty, eight of whom were white men, returned home. When, on the 3rd of August, 1830, she arrived at Oahu, weeping and wailing was heard night and day. The loss of so many active and fine men was felt as a national calamity, and formed a sad conclusion of the sandal-wood trade of the Sandwich Islands.

Eromanga, after this time, was constantly visited by similar expeditions, got up by both Polynesians and white men. It appears that the island had just been annoyed by a party of sandal-wood traders, who had killed several of the natives and robbed their plantations, when on the 29th of November, 1839,

the good ship "Camden," with the missionaries Williams and Harris on board, hove in sight at Dillon Bay. The Eromangans, unable to guess the glad tidings about to be made known to them, thought it was that sandal-wood party returning to repeat the offences. That very day there was to have been a great festival on shore, and near the beach heaps of yams and taro had been piled up for that occasion. Fearing that portions of them might be carried off, the natives tried to prevent the landing of the strangers; but finding their signs misunderstood, and no heed taken of the absence of women and children, a party, headed by chief Kauiau, commenced the attack. Poor Harris was the first struck down; Williams ran into the sea, but before able to reach the boat he too was a dead man, and his body, like that of his unfortunate companion, cooked and eaten. In 1859, the missionary Turner visited the scene of the massacre. The chief who headed the attack was still alive and was even induced to go on board the "John Williams," when long and silently he gazed upon the portrait of the man whom his murderous hand had made the martyr of Eromanga. During an interval of twenty years the sandal-traders had obtained a firm footing on this notorious island, the wood being still so plentiful that one firm employed about sixty men to cut it in the bush. But they found the Eromangans reluctant to work, and had to import labour from Lifu, Vate, and other islands. This reluctance may be explained by bearing in mind that all Polynesians work more willingly and better abroad than at home, and also because a belief had taken hold of the mind of the Eromangans that a dysentery, which in 1842 carried off a third of their number, was owing to some *hatchets* obtained from a sandal vessel, inducing them to throw the implements away. Another incident may have prompted them to keep aloof from contact with sandal-wood traders. In 1843, two vessels under British colours, the "Sophia" and the "Sultana," and a third, said to have carried the flag of Tahiti, manned by sixty Tongans, commanded by chief Maafu, and under the supreme leadership of a Mr. Henry, an Englishman, arrived at Eromanga for the purpose of forcibly cutting sandal trees. The party, armed with muskets, landed, and cut and embarked a quantity of the wood. For the first few days the Eromangans were friendly, but at the end of that time some of their number, having stolen three axes, a disturbance took place, when one of the supposed thieves was shot by a Tongan. The fire was returned by arrows, and mortally wounded a Tonguese. In consequence of this affray, Henry and his party left Eromanga, and proceeded to Vate, where the men were again landed, armed as before, and directed to cut sandal-wood, the whites prudently remaining on board. This

robbery could not but lead to evil consequences. Before long there was a battle with the natives, who, having no muskets, sustained a loss of twenty-six killed, whilst none of the intruders were wounded. In a subsequent storming of a fort more natives were killed, and the remainder retreated to an island, where they took refuge in a cave. The sandal-wood party, not satisfied with their triumph, pursued them, and finding that firing produced no apparent effect, they piled combustible material before the mouth of the cave, and setting fire to it, smoked the poor natives like rats, until all were suffocated. History repeats itself, for the same horrible scene here enacted by lawless savages was copied two or three years later by an heroic French general in Algeria.

The Vateans were not long in the strangers' debt, the crews of two English vessels, engaged in the sandal-wood trade, the "Cape Packet" and the "British Sovereign," having been massacred by them a few years afterwards. The "Cape Packet" was betrayed into their hands by a few discontented South Sea Islanders on board, whilst the "British Sovereign" had the misfortune to get wrecked, and its company, tormented by hunger and thirst, made for the shore, where all, with the exception of one Englishman and a boy, were clubbed and cooked. There seems to have been no provocation on the part of the strangers, and the sole cause for killing them appears to have been a desire for the bodies and clothes of the unfortunate men.

But Eromanga and Vate are not the only spots notorious for quarrels between traders and natives of the soil. Nearly every island of the South Pacific where the much-coveted wood is found, has become the theatre of bloodshed and murder. In most cases, it is impossible to say who is to blame. The Christian missionaries, almost invariably taking the side of the natives, lay all the blame upon the traders, whilst the traders attribute every quarrel to the undeniably ferocious disposition of the aborigines. Both sides of looking upon the subject came out in bold relief at Sydney during the trial of Captain Lewis, the superintendent of a sandal-wood establishment at the Isle of Pines, who was accused of killing a native of Mare and wounding others. Mare first became known as a sandal-wood island in 1841, when a whole boat's crew, supposed to have belonged to the "Martha," of Sydney, was massacred.* About 1843 the islanders attempted to capture

* The Sandal-wood of Mare may be identical with that of New Caledonia, lately described by Vieillard under tha name of *Santalum austro-caledonicum*, and named "Tibéan" by the aborigines of that great island. Macgillivray says, "The Sandal-wood trees of the Fijis, Aneitum, and the Isle of Pines, constitute *three* distinct species."

the "Brigand," which, however, was frustrated by the prudence of the captain. An attack on the "Sisters" unhappily proved successful, and since that time a number of white lives have been sacrificed in trading with Mare for sandal-wood. When H.M.S. "Havannah," Capt. Erskine, visited the Loyalty Islands, it was learnt that Capt. Lewis had shot a native, who with some others attempted to board the "Will-o'-the-Wisp." The justification of his conduct given by Capt. Lewis not being deemed sufficient, a complaint was lodged at Sydney, in consequence of which Lewis was arrested on an accidental visit to the place, and on the 7th July, 1851, brought to trial for murder. Though every effort was made to obtain a conviction, the jury found the prisoner not guilty. Capt. Lewis then returned to his station, and one of the first acts of the natives was to capture his cutter and murder the whole of her crew.

Owing to the ferocious character of the Polynesian natives in whose islands the sandal-trees grow, and the difficulty hitherto experienced to put this trade upon a different footing than it is at present, the loss of life resulting from this species of commerce is proportionally much greater than experienced in the whaling trade, with which it ranks as the most adventurous of callings. Mr. M'Gillivray, who is now employed in the sandal-wood trade, states that the profits obtained from this species of commerce are sometimes enormous, whatever that may mean. Lieut. Pollard, formerly of H.M.S. "Havannah," has furnished more satisfactory estimates, as far as the South Sea is concerned, and shows that in the case of the "Julia Percy," which cost £1200 with her boats, yielded in one voyage, after all expenses, including interest, and amounting to £2595, had been paid, a clear profit of £1182 4s. to the owner. The Australian vessels employed in the collection are in general small, and such as have been nearly worn out, and are unfitted for other branches of commerce. The crews, collected at Sydney, or picked up amongst the islands, are almost universally paid by the *lay*, as in whaling voyages; that is, by a share either of the wood collected, or of the value calculated at a low fixed price (about £12 a ton), the proportion for each seaman being one seventy-second part, so that for every ton of sandal-wood he receives £12. The amount of trade between the Australian colonies and China depends entirely on the price of the commodity in the market, which varies from £40 to £12 a ton.

THE ZOOLOGIST AT SCARBOROUGH.

BY THE REV. G. ROWE, M.A.

Scarborough is too famous as a hunting-ground for the marine naturalist to render it necessary for me to reiterate its claims to notice, yet I know by sad experience how very possible it is to go to a rich preserve of this sort only to find one's most diligent search repaid with empty vessels; and I may therefore be permitted to rehearse the favourite spots known to me for the benefit of any of your readers who may be there without a guide. These are then, first, the rocks beneath the castle. Here the blue lias stretches out to seawards in tabular masses almost perfectly level, the dip being really to the west. The flat strata are constantly breaking up, and wearing away, leaving lines of pools beneath their basset edges, which at once catch the eye as likely spots for the naturalist's labours. Occasionally, these pools deepen into some fissure, six feet deep, and then the cooler water (assisted by its greater quantity) is the prolific habitat of numerous delicate algæ and mollusca, which do not thrive in the warmer and sun-lighted shallows.

The ground-plan of these slightly inclined lias beds, together with their superficial pools, is overlaid and obscured by the confused *débris* from the sandstone cliffs above. Some of the fallen blocks are so large as to remain stationary under all but the most violent storms. There is one great mass, which I have seen for the last two years, whose under-side slopes up at one corner, so that at low-water the explorer may twist his head and shoulders under it, and then appears the advantage of being exceedingly short-sighted; for within an inch or two of one's nose is a dripping mass of seaweeds and zoophytes, where beautiful nudibranchs display their rich colours and curious anatomy, and the pretty little univalve, *Cypræa Europæa,* crawls like a living pearl among the swelling lobes of the dead-man's thumb (*Alcyonium digitatum*). The whole aperture teems with life; the weed-covered sides conceal *Littorinæ, Lacunæ, Chitons,* and other mollusks, and in the dank shades of the pools beneath beauteous *Actiniæ* perennially expand their rays, green, yellow, and scarlet, and bright star-fish glide over the rocks with the stealthy motion of their thousand flexile suckers, each of which is a marvel of mechanism. Here, in the month of June or July, you may gather in half-an-hour such a store of living things, animal and vegetable, as shall afford study and recreation for a month.

The second spot worthy of mention is a ledge of flattish rocks, immediately opposite the bridge. These are only uncovered for a short time at low-water, spring tides. They produce a

luxuriant crop of Tangle, upon the fronds of which may be found abundantly the prettiest of all our limpets—the fragile *Patella pellucida.* It is worth while to pull up some of these large algæ by the roots, which are composed of an interlaced mass of fibres. Their interstices always harbour small shells and crustaceans, and are the special habitat of *Turtonia minuta.* Creeping upon the leather-like fronds of the same plant may also be occasionally discovered one of the less common chitons (*C. ruber*), which when seen alive in its home is amply entitled to its specific name. The rock-pools here, too, are crowded with delicate sea-weeds.

There are similar ledges of rocks exposed at low-water further to the south, beyond the Spa; but except a fine sea-hare (*Aplysia hybrida*), which I once found in a pool, I have never obtained anything peculiar from them.

Such being the best hunting-grounds known to me on this part of the coast, it was with a pleasurable anticipation that, on the 8th of April last, I ascertained I should have an hour to wait at Scarborough on my way to Filey, and that the period of this delay nearly coincided with that of low tide. As it was during the neaps, I determined to beat the cover beneath the castle; and, accordingly, the shortest possible time after the arrival of the train saw me descend the north face of the harbour-wall, and scramble over the rocks towards the breakers. Alas! the one glance from the pier disclosed a rising tide. Already my great blocks were besprinkled with spray, or moated by the fast advancing waves. However, it was not a time for long consideration, as the ground would soon be covered, so I commenced my search with a will. Passing for the present the shooting masses of *Fucus serratus,* which hangs like shaggy locks upon every stone, and is now full of fruit, I got to the lowest pools. Great groups of *Laminaria digitata* predominated, the long strap-like divisions playing in the rushing water with graceful ease. Drawing these up carefully, I gathered a few good specimens of *Patella pellucida* from the lowermost ends, and fancied that the animals clung with more than usual tenacity to the fronds, so as to require a detaching violence which threatened to damage the delicate shells of this gasteropod. *Laminaria bulbosa* occurs in much less quantity, and did not appear to produce anything. Selecting some of the smallest of these large algæ as book specimens, I next succeeded in approaching close to one of the bigger stones, whose dank weed-shrouded back stood out like an elephant from the lower ranks around. The waves were breaking against the seaward side, and dancing and curling under it; but balancing myself carefully on two slippery points of rock, I began to collect in hopefulness. The lower surface was profusely covered

with the singular cup-shaped fronds of *Himanthalia lorea.* These were just putting out their elongated receptacles, whence the plant derives its name of sea-thongs. Some of the older and larger examples were quickly transferred to my box for after examination, and others more delicate, which were intended for preservation. One of the former afforded a characteristic instance of the multiplicity of organized objects with which nature loves to people every cranny to excess. The whole frond was less than two inches in diameter, but its wrinkled edges, bent back upon its short stem, formed a complete shelter to hundreds of living creatures. First there was a nest of young mussels, covered with the perplexing hairy epidermis common to all, and permanent in one, of the British species. Among them small crustaceans and strange-looking larvæ struggled and writhed to conceal themselves. Several patches of a *Lepralia* contained by computation at least one thousand individuals, and the polypidom of another zoophyte (*Sertularia operculata*), straggled over the rest, with its many scores of occupants. Besides all these, there were bits of nullipore here and there, and on pulling up the young mussels I disinterred an interesting group of three young *Odostomia dubia.* It is impossible to behold without the warmest admiration such a happy family of dissimilar organisms, each pursuing its own nature in the selection of its habitat and food, and in its other functions of life, and all within the compass of a space not larger than a crown-piece.

But I must return to my work on the rocks. In less time than I take to write it, a dashing wave came bouncing over my ancles, and forced me to beat a hasty retreat. Yet it was fortune favouring me; for the next haul from a pool was a long frond of *Lam. bulbosa,* closely examining the dripping extremity of which, I detected a minute, sparkling drop of pearly blue. What could it be? Something which I had hitherto never seen, at least in its living state. With the utmost care I detached it, and placed the fragile shell in a separate box, much revolving what it should be. Further search was rewarded by six or seven other specimens, and having now more leisure to examine them, I concluded they must be one of the minuter members of the genus *Trochus,* but so different from its dead and faded state in our cabinets, that I did not instantly recognize the species. Soon all the fronds of the great seaweed which thus unexpectedly produced a new shell of my own collecting were exhausted, and I was reduced to the previously despised bunches of *Fucus serratus.* Here the striking abundance of the egg-capsules of a *Lacuna* suggested the neighbourhood of the animal, and I was able to obtain about half a dozen specimens of *L. pallidula.* They occurred, however,

much less frequently than the *patella* above noticed. On the contrary, there was a rich profusion of sea-anemones (*Actinia*). Their crimson bulbs studded the shady pools in groups, often spreading their petal-like arms with charming effect. An unusually large individual, revelling in orange and green, was especially attractive; and almost every crevice was filled with what at first sight appeared to be little hemispherical heaps of clean gravel, but which were, in truth, the closed bodies of *Actiniæ*, awaiting the coming of the tide and their dinner-time. Perhaps these "flowers of the deep" are among the most entertaining denizens of the rock-pools, for their beauty and variety never fail to arrest the attention of the most casual observer.

Again the relentless tide drove me back. Yet, lingering over the pleasant recreation, I next raised a stone, which the *Actiniæ* on its edges told me had not been moved for some time. Its bottom was a scene of confusion and distress. Here a long worm wriggled out of sight; there a crustacean, all legs, scuttled over the edge and dropped into the water. A *Chiton* sealed its valves hermetically to the stone; *Littorinæ* and *Trochi* shut themselves up. They need not have been alarmed, for their disturber's eyes were fixed on the spot where five pearly drops of irridescent blue indicated as many of my lately-discovered prizes, which I now determined to be *Trochus helicinus*. Though not quite so fine as those on the algæ, they were more numerous; and before I was finally driven in by the waves, I managed to obtain about twenty from this new habitat, a number increased nearly fivefold on a subsequent visit. This pretty univalve does not appear to range far to the south of Scarborough, though it is found a long way up the coast of Scotland; but doubtless a close inspection would discover it in many similar localities on our own shores.

Retiring slowly over the gently sloping beds of lias, I was next struck by the recent look of the holes of boring-shells, and presently detected the valves of *Pholas crispata* and *Tapes pullastra*. A little industry in the use of a clasp-knife soon cut them out of the saturated and softened rock, but I was unable to get any living specimens. The many theories which have been invented to account for the way in which these animals bore their habitations may be instructively studied, both here and at Filey. I would draw attention to one important fact, viz., the ease with which the wet rock is cut, compared with the difficulty of smashing it when dried by exposure to the atmosphere. It is ever so, whether the material be the limestones of Yorkshire and Dorset, the chalks of Flamborough and elsewhere, or the red sandstones of Torquay and its neighbourhood.

Here my operations came to a close for the time. They

had attracted the remark of a party of boys, who were making a last desperate foray upon the crabs—with indifferent success indeed, for if *Cancer* could but make good his refusal to be taken at sight, the rapid strides of the tide quickly beat off his assailants, and left him in quiet possession of the field. A small eel, under the title of a "Skittle-jack," was brought to me, as likely to be of interest to a man that seemed to be very easily amused; and an animated discussion as to whether *all* the smaller mollusca did not ultimately grow up into "covings," *i.e.*, mussels for bait, was stifled by the biggest lad declaring that crabs were the best, but shells he thought "nowt aboot."

ON THE PHOTOGEN OILS.

BY J. W. M'GAULEY.

The Natural Products.—The fluid bitumens obtained native, and those derived from coal and shale, are believed to be identical, or at least so closely allied as to yield products very nearly resembling each other. Native bitumens are generally considered to be of vegetable origin; a few geologists, however, believe they may be due to the slow subterranean alteration of fish, deposited at some geological period. They certainly differ from coal, in never exhibiting any organic tissue or structure under the microscope, and in consisting of viscous matters, which ordinarily melt at or below the temperature of boiling water. The solid bitumens are termed *Asphaltes*. The semi-fluid bitumens consist of *Asphaltine*, which is solid and fixed, and *Petroline*, which is fluid or volatile; and their constituents may be separated, by exposing them to the temperature of boiling water, in a close vessel. They are found as wells or springs of viscous fluid, which has been forced up through the deposits above them, and which, in some instances, hardens at the surface and edges.

The rock oils, or native naphthas, are obtained in many parts of the world, and hence their various names—Persian naphtha, Rangoon tar, etc.; the old generic term *Petroleum* being, as is perceived (*petri-oleum*), a mere Latin form of the English appellative. They are probably all alike in constitution, and when properly rectified none of them contains any oxygen, or has any tendency to unite with it—an important quality, as they are often used for the lubrication of machinery; but, though consisting only of carbon and hydrogen, they are very complicated compounds. They are found at Amiano in Italy, Clermont in France, Neufchâtel in Switzerland, and many other

parts of Europe; and vast quantities of them are obtained in Asia and America. The amount procured in some localities is immense; four hundred thousand gallons of petroleum are obtained annually in a small district round the town of Rainangong, in the Burmese Empire: it is used by the Burmese as oil for lamps, and, mixed with earth or ashes, for fuel. In America also the produce is extremely abundant: eighteen hundred gallons a day were afforded by one spring of petroleum, which was found near Pittsburg, on the Allegany river, in boring for salt. For a considerable time the wells in the valley of the Mississippi yielded daily ten or twelve barrels of the crude oil each, but their product was observed to diminish according as additional wells were sunk in the neighbourhood. Fifty thousand gallons are obtained each day in the United States. The oil region there reaches from the 65th to the 128th degree of longitude west of Greenwich. Very large quantities are found also in Canada: the *Spouting* wells of that locality gave at first an abundant supply, and it is supposed that three hundred thousand barrels of the crude oil have already been obtained from them; but one-half was wasted, from the mode of managing the wells being very imperfect, and from its being extremely difficult to control them when they had once been tapped. In Canada, as in the United States, the supply, however great, appears to be limited; for the product of the Spouting wells—the chief source of petroleum there—has already fallen from twelve thousand to four hundred barrels a day, twenty-eight out of the thirty wells having ceased to yield any; and, as we learn from the most reliable authorities, when a pump is used, little besides salt water is obtained from them. Nor, although the oil region would appear from the geological conformation to extend through the whole peninsula of Upper Canada, has much success attended a search for oil beyond the limited area of two miles square, within which the wells may be said to be confined.

Rangoon tar, which is perhaps the most abundant of all the native naphthas, contains a large quantity of paraffine a substance which, as is well known, is manufactured into the most beautiful candles. When this tar is subjected to distillation at a temperature of 212 degrees, eleven per cent. of fluid hydrocarbons, containing no paraffine, passes over; but as the temperature is raised the amount of the distillate diminishes, while that of the paraffine increases. At temperatures between 320 degrees and the fusing point of lead the products begin to solidify on cooling, and their paraffine may be separated by pressure. In the last stage, when the heat has become very considerable, pitch-like substances pass over; and after the process is finished, four per cent. solid matter remains in the

still. The distillate from Rangoon tar is freer from odour than that obtained from any artificial naphtha. As the natural and artificial photogens are purified in a similar way, we may treat of the purification of both at the same time.

The Artificial Products.—Fluids very similar to, if not identical with, rock oil, are obtained by the destructive distillation of cannel coal, shale, peat, etc., but most abundantly from boghead coal, and the shales which bear the nearest resemblance to it. We may remark that naphtha and the photogenic oils are extremely different in their properties. Photogen, the paraffine oil of commerce, may be easily distinguished from coal naphtha by its specific gravity, since no amount of redistillation will bring naphtha below 0·850, while the specific gravity of the ordinary kinds of photogen does not exceed about 0·750. Photogen may indeed have a specific gravity of 0·900, but then it will most probably contain a large amount of paraffine.

The manufacture of photogenic oils from coals and shales is a recent application of science to the further utilization of these valuable substances. Not that their capability of affording such products is a late discovery, for this important fact seems to have been ascertained by Clayton, during his researches regarding the manufacture of gas from coal; but the matter was neglected by him, as beside the immediate object of his experiments. So that, as occurred with coal gas, a long period intervened between the discovery of photogen and its application to any useful purpose. Though its production during the destructive distillation of bituminous coal was frequently noticed by succeeding investigators, and many experiments were made with results more or less satisfactory, no thoroughly successful process was invented for obtaining it until the middle of the present century. The discoveries which led to the establishment of this important manufacture are not due to any one person, but it owes much to the labours of Reichenbach, and it was brought to its full development mainly through the ingenuity of Young. The difficulty of obtaining a remunerative product consisted chiefly in the necessity for a proper regulation of the heat employed. The best temperature for the production of photogen is between 650 and 700 degrees, and the latter must never be exceeded. Should it rise to 800 degrees, that is, to dull redness, the products are principally gaseous. A less elevated temperature is required if superheated steam is thrown on the materials, either as an aid to an external fire, or without the use of one. It is indispensable also that certain impurities shall be got rid of. Destructive distillation of every kind may be looked upon as a combustion, which is limited, because effected only by the oxygen which is contained in the substance itself: in all cases the results are

extremely complicated, and in most they include undesirable compounds. If the body submitted to it contains nitrogen, ammonia and other nitrogen combinations are among the products; and in a similar way, if sulphur is present, there are compounds of sulphur. The amount of photogen does not depend on the temperature only, it has an important relation also to the constitution of the crude tar. The tar furnished by coal is more dense than that from bituminous schist; that from the Breckenridge cannel coal, which is supposed to be the most highly bituminous of all, yields about thirty-two per cent. of tarry oil; and the latter may be expected to give seventy per cent. of the pure product.

If pure, the photogenic oils contain almost exclusively *Tolmene,* which boils at about 230 degrees, and *Cumene,* which boils at 314 degrees, the less volatile oil being most probably carried over by the vapour of the more volatile. The proportion in which these are present depends very much on the temperature at which the distillation is effected. In Germany the distillate is usually divided into two portions, the more volatile being set apart as *photogen,* and the less as *solar* oil; but in this country the two are used together. The oils which distil over between 340 and 400 degrees contain creosote; above 400 degrees there is cumene with other compounds, and but little tolmene. It is evident, therefore, that in the manufacture of photogen too much attention cannot be paid to the temperature; and hence the numerous projects for securing a proper one. If a naked fire is used, a due regulation of the heat becomes extremely difficult, and the material is very likely to become overheated in certain places, which causes the evolution of gaseous instead of vaporous products; but this may, to some extent, be prevented by keeping the coal, shale, etc., contained in the retort, in motion. To obviate the necessity of using a naked fire, or to render a more moderate one sufficient, steam is employed, but it should be superheated, and must not be derived from water, with which the materials have been previously wetted, as this would tend to the production of cold rather than heat. Bituminous shale is, however, an exception in this respect, as the presence of water protects it from too high a temperature, and the vapour generated from it, helps mechanically to carry off the photogenic products as fast as they are volatilized, so as to prevent their decomposition. Superheated steam both heats the material and aids in its decomposition, and it may be raised to the proper temperature by being made to traverse coils of tubing, placed within a furnace—that used in the distillation, if any such is employed. But since the steam is decomposed at a high temperature, its gaseous constituents entering into combination, and forming

gaseous compounds with the carbon, *burnt* air is often used instead of it; and this is found to give nearly twice as large a product as a naked fire. As, however, the cost of fittings for either steam or burnt air is, in some instances, more important than the saving they effect, a naked fire is still being generally used, both in the production and the purification of photogen. Baths of fusible metal also have been employed with great success, as a means of regulating the temperature; and they have been found to improve not only the quantity but the quality of the result.

Bitumens and bituminous schists give the same products, but the former leave a less amount of earthy residue: the schists may be expected to yield about fourteen per cent. of oil. The *heavy* oil, obtained among the products from peat, answers well for burning; it gives a dazzling white light, but on account of the large quantity of carbon which it contains, the wick requires to be trimmed after about eight hours. If bituminous slate is used for the production of photogen, it must not be too minutely divided, or the high temperature, which will arise from the free escape of the vapour being prevented, will cause gases to be formed in abundance.

To obtain the photogen in a state of purity, it is necessary to subject the crude product to certain processes, which are of great importance. The demand at present existing for coal oil is so great, as to render the manufacturer careless about an adequate purification; but a neglect of this, however strong the temptation, can arise from only a short-sighted policy; and the difficulty of obtaining a good article deters many persons from using an oil which, with a proper and honest system of manufacture, is capable of giving a convenient and brilliant light. In France, where the vegetable oils are abundant, pure schist oils are easily had; even in Germany, where the inducement to supply an inferior article is strong, since oils and fats are comparatively less plentiful there than in Britain, which is supplied with an abundance of animal oil by its whale fishery, a good photogen is easily obtained; and in America, where great care is bestowed on the preparation of the oil, and also on the construction of the *lamp*, to which far less attention is paid by us than is requisite, photogen is preferred to almost every other source of artificial light. There is enough to encourage the manufacturer to a due purification of his product, since it is possible to obtain so much as one hundred and forty gallons of good oil from one ton of cannel coal; or from one hundred parts cannel coal, forty parts oil, and ten parts paraffine, with other substances applicable to lubrication, to the solution of caoutchouc, and other useful purposes.

The purification of photogen must be effected by chemical

means, because the impurities cannot be separated by any method of filtration. The viscous, semi-solid, and solid hydrocarbons suspended in the lighter oils must be thoroughly removed, since a very small amount of them in the photogen would cause the production of smoke during combustion, on account of the extra quantity of carbon which would be present. Most of them may be got rid of by careful distillation, at a regulated temperature; and the remainder by treatment with sulphuric acid, which unites with them, while it has very little effect on the lighter constituents with which they are associated. The more volatile impurities, which render the oil odorous, and increase its inflammability, may be separated by bichromate and manganate of potash, since they are easily oxidizable, or even by animal charcoal. The more offensive the smell of the oil the more easily it takes fire, and, therefore, the more dangerous it is. Any sulphuric acid which may remain in suspension, on account of not having been removed by washing, is neutralized by soda, which takes away also any carbolic acid or creosote which may have been generated by decomposition of sulphuric acid, determined by the carbon of the easily decomposible compounds in the distillate. The alkali takes away any sulphide of hydrogen present, and perhaps other fetid sulphur compounds. Alternate use of soda and sulphuric acid renders the oil very pure. Sulphuric acid, besides being cheaper, is more effective than nitric or nitro-muriatic. A very common process of purification consists in adding sulphuric acid to the crude oil after the tar has been separated from it, agitating the mixture, and allowing it to settle; then drawing off the clear liquid into another purifier, in which caustic soda or lime water is added, agitating and allowing to settle. When the resulting clear liquid is distilled at a temperature between 400 and 600 degrees, tar remains in the still. If the distillation is not very carefully conducted, volatile, and therefore highly explosive compounds will result, and the oil will be dangerously inflammable. In Hamburgh, which is remarkable for the goodness of its photogen, the distillation is repeated several times, after which the oil is treated with sulphuric acid; it has then but little smell, since the material from which it is made is very free from sulphur. The purified oil should be without colour, and inodorous, or at least with only a slight aromatic odour. The smell of bad photogen is diminished by exposure to the air, and even by keeping it for a few days in casks, and its colour is destroyed very rapidly by mere exposure to the light. Should creosote be present, it will cause a smell, and will char the wick. The freedom of the wick from charring is, therefore, a test of the goodness of the oil. So much as six or seven per cent. creosote is often found in what is sold as *doubly*

purified coal oil. Though large quantities of photogen oils are manufactured in this country, the foreign kinds are extensively used. In 1857, seven hundred tons were imported, and the imports are larger at present.

CRYSTALS IN THE INTESTINES OF ARTEMIA SALINA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

THE *Artemia salina*, or brine shrimp, is the most elegant of British entomostraca; but though well known to the professed naturalist, it escapes the general observer from the peculiarities of its mode of life. They sometimes occur in salt marshes, but their favourite haunts are brine pans, in which sea-water is evaporated; and when the solution reaches a strength that would be fatal to most forms of marine zoology, the little brine shrimp is singularly happy, and multiplies its species to an amazing extent. The visitors to Lymington, in Hampshire, find it abundantly in the tanks or reservoirs, called "clearers," to which it often imparts a lively red tint, and it is found in equal plenty in the salt works near Montpellier. Another locality is Hayling Island, near Havant, on the Hampshire coast, and from this place Mr. Burr brought the specimens which I have been able to examine. The little creatures are about half an inch long, of a beautiful pearly hue, much redder in some individuals than in others. The head is rendered conspicuous by a pair of prominent and exquisitely formed eyes, composed of many lenses, like those of the dragon-fly, and standing upon transparent stalks, which facilitate the study of their mechanism under various microscopic powers from fifty to three hundred. The head is further adorned by large flat two-jointed cephalic horns, and the mouth is furnished with two mandibles, the terminations of which exhibit thousands of minute teeth, which require a magnification of 400 or 500 linear to be distinctly seen. The thorax consists, according to Baird, of eleven segments, to each of which is attached a pair of branchial feet, lobed in a peculiar way, and adorned with bristles, beautifully toothed and branched. The effect of the eleven pair of branchial feet is to give an appearance of considerable breadth to the thoracic part of the animal, and make the abdomen, which is composed of six slender joints, ending in two small caudal appendages, look like a long flexible tail, and it acts like one when the creature swims. The motions are incessant. Seen

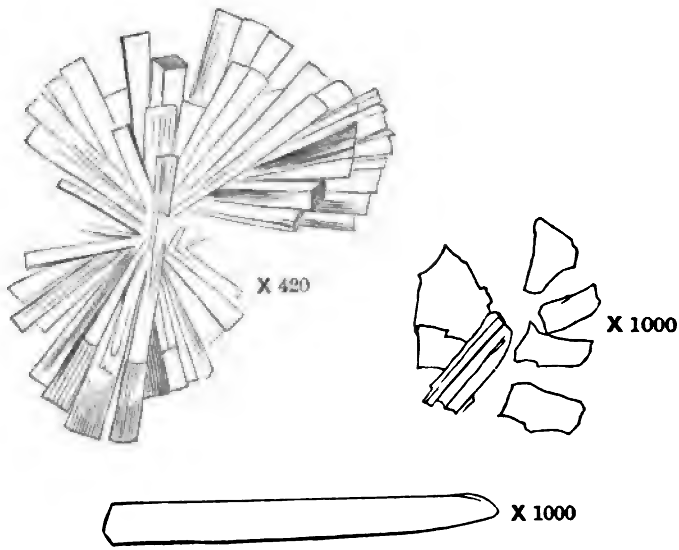
with the naked eye, or with a low power, the branchial feet are constantly waving like graceful plumes, and they carry their owner now up, now down, now this way, now that, the movements being rapid, elegant, and under perfect control. In the females, which are most common, a large squarish pouch, situated under the first joint of the abdomen, carries numerous round dark eggs, and forms a conspicuous object whichever way the Artemia is viewed.

As is common with entomostracans, the young brine shrimps differ considerably from their parents, but with successive moultings acquire the same form. The gill feet are exquisite objects for the microscope, and powers of 500 to 1000 linear reveal a multiplicity of structures, amongst which vessels bulging in the middle, and tapering towards a duct at each end, are very noticeable. The incessant motion is essential to respiration, by bringing fresh currents of water into contact with the delicate membranes of which the gills are composed, and it is also subservient to purposes of locomotion. If a female, with her external ovary filled with eggs, is thrown into fresh water, she survives some time, but, though the gill feet labour as hard as before, she fails to swim, being too heavy for the lighter medium. When replaced in her favourite brine, the swimming proceeds as vigorously as ever, and no harm appears to result from a temporary immersion in the fresh fluid.

It was about the middle of June that, through the kindness of Mr. Burr, I received my first batch of these pretty creatures, and on the 20th I noticed in the intestines of some, beautiful groups of crystals, composed of prisms arranged in aigrettes, very much like the figures of uric acid in *Micrographic Dictionary*, plate 8, fig. 1 *l*, and exactly resembling the larger forms depicted in Dr. Glover's *Manual of Chemistry*, plate 11, fig. 47 *b*. Every specimen of this batch, which I subsequently examined, contained crystals of the same form in more or less abundance, and one was crammed with them, a single mass composed of many coalescing groups, measuring 22—1000'' in its longest diameter. With the polariscope they presented a beautiful appearance, and this fact, together with their virtual insolubility in water, confirmed the impression that they were composed of uric acid, a substance well-known to exist in the secretions of crustacea; but not, so far as I am aware, previously noticed as forming calculi in any entomostracan.

On the 4th July Mr. Burr obligingly gave me another supply of specimens, brought a few days before from Hayling Island. These were in a much more delicate state than the preceding. None were healthy, and many were dead, with oddly stiffened tails. My mode of examining these, as in the former case, was to cut off the abdomen, place it in a drop of clean fresh water,

cover with thin glass, and apply very slight pressure, so as not to smash the crystals. To my surprise I did not find in any of these a single aigrette, but multitudes of more or less amorphous masses, tending to regular crystalline forms. A few of these masses, but by no means the smallest, are given in the annexed sketch, and it will be seen from the appended statement of magnification, that they were very small in comparison with the aigrettes in the first specimens. The aigrettes were beautifully shown with a one-fifth objective and second eye-piece, giving a power of 420, while the examination of the amorphous masses was advantageously made with Smith and Beck's one-twentieth and first eye-piece, giving



CRYSTALS IN INTESTINE OF ARTEMIA SALINA.

1000 linear, and manipulated with quite as much facility as the lower power. Although this high magnification was necessary for accurate examination, the amorphous particles could be discerned with as low a power as two hundred and thirty when the attention was directed to them. In many cases the intestine was nearly filled with these particles, which in the aggregate exceeded in quantity the dark fœcal matter.

The approximation to regular form of crystals varied greatly in different individuals. In some, every particle might be described as amorphous; in others, many imperfect crystals could be seen, and in one I noticed two regular hexagons; one of them such as would be obtained by inscribing a hexagon in a circle,

and another such as would result from applying a right angled triangle to each of the smaller ends of an oblong figure. Both of these were exceedingly small, and required the one-twentieth for their adequate display. Referring again to plate 8 of the *Micrographic Dictionary*, the reader will see, in fig. 2 *a*, how a hexagon may be formed by the coalescence of two rhombs, and two half rhombs, or triangles, of uric acid. I looked in vain for perfect rhombs in my specimens, but Professor Tuson, to whom I gave some of the second batch of Artemia, discovered some in his.

It would be absurd to place much faith in generalizations drawn from a few observations, but it is curious that my first supply of brine shrimps, containing the aigrettes, lived for some weeks in confinement, and mostly perished through microscopic examination, while the second supply, containing the amorphous lumps, died off very fast. Does the amorphous condition indicate a rapid deposition, arising from an excess of uric acid incompatible with the little animal's well being? Living far away from the Hampshire brine pans, I cannot expect to unravel the difficulty; but where there are brine pans, there are no doubt "Intellectual Observers," and I hope some of your readers will give to this curious question the attention it deserves. I should also like to know whether crystalline forms are common in the intestines of other marine entomostraca, and whether their appearance at all, or only their appearance in excess, is a symptom of bad health. I cannot believe that concretions, relatively large in proportion to the intestine, can be productive of comfort, and some of them were so stuffed up with angular particles as to suggest the idea that a visit from Dr. Civiale, with an apparatus adapted to microscopic lithotrity, would have been a desirable event.

On the 19th July I had only one Artemia left, and it was still very lively; but on looking attentively into the bottle it appeared to have acquired a famous long tail, which it swished about as it went. A pocket lens explained this appearance, and showed *nine* cylindrical pellets of fœcal matter, equidistant from each other, and held together by some transparent material. The pellets proved, on examination, to be full of amorphous particles, but I could not succeed in making out how they were strung together, whether by a thin membrane carried away from the intestine, or by a mucous secretion. I relieved the Artemia of this strange appendage, and it seemed none the worse after being replaced in its bottle.

I have called the deposits *uric acid,* but I had not enough of the material for definitive experiments. Professor Miller states, in his *Elements of Chemistry,* that "uric acid crystallizes in rhombic tables, the outlines of which are frequently rounded;

but when it is deposited from animal fluids the form of the crystals is often much modified." The same authority says that "pure uric acid is a white crystalline powder, requiring 10,000 parts of cold water for its solution." This being the case would account for no harm being done to my crystals by immersing them in drops of fresh water. The urates, although sparingly soluble, are much more so than uric acid. Urate of potash (neutral) is soluble, according to Miller, in forty-four parts of cold water; the urate of soda is somewhat less soluble, and the urate of ammonia is soluble in 1800 parts of cold water. The *Micrographic Dictionary* gives drawings of crystals of urates, none of which correspond—as some of its representations of uric acid do—with those in the Artemia, but it adds that their forms "are not very characteristic." In the article *Uric Acid,* in the same work, it is observed that "the crystals forming a natural deposit are almost invariably coloured, from combining with the colouring matter of the urine." Little crustaceans like brine shrimps would not be expected to colour this substance, and in all my specimens it was pure white, like glass.

I should recommend anybody looking for these crystals to cut off the abdominal segments before using any compression. If the entire animal is compressed, too much mess is made to see them clearly, and unless the abdomens are placed in clean fresh water, the observer is pretty sure to be troubled by the deposit of salt from the strong brine in which the creatures dwell.

THE COLUMNAR BASALT OF POUK HILL, SOUTH STAFFORDSHIRE.

BY J. JONES,

Secretary of the Dudley and Midland Geological Society.

We are so accustomed to regard the Giant's Causeway, and Fingal's Cave in Staffa, as the only British examples of columnar basalt, that perhaps the title of this chapter may appear indicative of some new discovery. This is not the case, however, for the peculiar columnar structure of the igneous rocks which occur in connection with the coal-measures of South Staffordshire, and also of the Clee Hills farther west, has been long known and recorded; but the face of basalt, which is now exposed at the extensive quarries of Pouk Hill, near Walsall, affords, perhaps, a finer section of this remark-

able structure than has ever been exhibited before. The hill is situated near the high road from Walsall to Willenhall, and about two miles from the former town. The basalt at this place seems to have been originally protruded from the neighbourhood of the Rowley Hills, about six miles distant, perhaps shortly after the formation of the lower coal-measures, for in an open working of the bottom-coal, to the south of the quarry, the basalt is seen reposing on the coal itself, which has been changed by contact into anthracite. In another section, exposed by cutting a tramway from the quarry, coal shales are seen to rest on the igneous rock, but they have not undergone any change; hence it is tolerably certain that the protrusion of the basalt took place immediately after the formation of the Bottom coal of the district. Mining operations have recently been carried on completely under the knoll of basalt, and no trace of any pipe or vent through which the stream of molten matter could flow has been discovered. Hence it is now generally admitted that the stream must have had its origin farther to the west, and after passing through the lower coal-measures some distance, it found an opening, and thus formed a large mound of igneous matter. The composition and mineral characteristics of this basalt are the same as that of the more remarkable localities in Scotland and Ireland. The central part of the mound has been long worked away; but, from the general arrangement of the columns, and the way in which they curve towards a point which would be directly over the middle of the quarry, there is reason to believe that the columns radiated regularly from the cooling surface of the basalt, and in the interior of the boss, assumed a vertical position. The workings on the north-eastern side show these vertical columns for a space of about thirty yards, and many of them are upwards of twenty feet in height. They are of a rude pentagonal form, and in some cases above two feet in diameter. Towards the top of the section the columns are smaller, and bend over with great regularity. A few months ago the Midland Geological and Scientific Society held one of their usual field meetings at the quarry, and examined carefully the geological features of the locality. The material is extensively used for road-making and paving in the neighbourhood. At the works of Messrs. Chance, glass makers, near Birmingham, this basalt has been melted and cast into candlesticks, vases, and other articles, which take a tolerably high polish, and somewhat resemble in appearance the black Derbyshire marbles. The mass of basalt at the Rowley Hills has also been extensively quarried for road purposes, and the largest excavation shows a very rude columnar arrangement of the igneous rock, but not nearly so well defined as that of Pouk

Hill. Of course, we are not maintaining that the regular and beautiful appearance of the Isle of Staffa, or the north of Antrim, is reproduced in South Staffordshire; but the approach is so near in the case of Pouk Hill that it seems worthy of more than mere local record. A few years hence, and the quarry will doubtless be worked out; and indeed we very much question if a section equal to the one recently exposed will again be witnessed, as the basalt is being rapidly exhausted, and hardly a day passes without some of the columns being demolished.

PASTEUR'S RESEARCHES ON PUTREFACTION.

THE following paper was read before the French Academy on the 29th June, and will be found in the *Comptes Rendus* for that date:—

"In every case in which animal or vegetable matter undergoes spontaneous alteration and develops fetid gases, putrefaction is said to occur. We shall perceive in the course of our examination that this definition has two opposite defects. It is too general, because it brings together phenomena that are essentially distinct; and it is too restricted, because it separates others which have the same nature and origin.

"The interest and utility of an exact study of putrefaction has never been misunderstood. Long ago it was hoped it might lead to practical consequences in the treatment of maladies which the old physicians termed *putrid*. Such was the idea that guided the celebrated English physician Pringle when he published, in the middle of the last century, his experiments on matters septic and antiseptic, with a view to illustrate his observations on the diseases of armies.

"Unfortunately the disgust inseparable from labours of this kind, joined to their evident complication, has hitherto arrested the majority of experimenters, so that nearly everything has still to be done. My researches on fermentation have naturally conducted me towards this study. . . . The most general deduction from my experiments being that putrefaction is determined by organic ferments of the genus Vibrio. Ehrenberg has described six species of vibrio, to which he gives the following names:—

1. Vibrio lineola.	4. Vibrio rugula.
2. Vibrio tremulans.	5. Vibrio prolifer.
3. Vibrio subtilis.	6. Vibrio bacillus.

"These six species, in part recognized by the first micrographers in the last centuries, have been since seen by all who

have paid attention to infusoria. I reserve, so far as it concerns me, the question of the identity or the difference of these species, and of the variety of their forms, subordinated to changes in the condition of the medium in which they live. I accept them provisionally such as they are described, and I arrive at the conclusion that these six species of vibrions are six species of animal ferments, and that they are the ferments of putrefaction. Besides this, I have shown that all these vibrions can exist without free oxygen, and that they perish in contact with this gas, if nothing preserves them from its direct action. The fact that I announced to the Academy two years ago, and of which I have recently pointed out a second example, namely, that there exist animalcule ferments of the genus Vibrio which can live without free oxygen, was only a particular incident appertaining to a mode of fermentation which is perhaps the most wide-spread in nature.

"The conditions under which putrefaction is manifested may vary considerably. Suppose, in the first instance, the case of a liquid, that is to say of a putrescible substance, of which all the parts have been exposed to contact with the air. Either this liquid may be shut up in a close vessel, or it may be placed in an open vessel, having an aperture more or less large. I will examine in succession what happens in the two cases.

"It is commonly known that putrefaction takes a certain time to manifest itself, and that this time varies according to temperature, neutrality, acidity, or alkalinity of the liquid. Under the most favourable circumstances a minimum of about twenty-four hours is necessary before the phenomenon begins to be manifested by external signs. During this first period the liquid is agitated by an internal movement, the effect of which is to deprive of its oxygen the air which is in solution, and to replace it by carbonic acid gas. The total disappearance of the oxygen when the liquid is neutral or slightly alkaline is due, in general, to the development of the smallest of the infusoria, the *Monas crepusculum* and *Bacterium termo*. A very slight agitation occurs as these little beings travel in all directions. When this first action of exhausting the oxygen in solution is accomplished, they perish and fall to the bottom of the vessel like a precipitate; and if by chance the liquid contains no fecund germs of the ferments I have spoken of, it remains indefinitely in this condition without putrefaction—without fermenting in any way. This is rare, but I have met with several examples. Most frequently when the oxygen in solution has disappeared, the vibrion ferments, which have no need of this gas, begin to appear, and putrefaction immediately sets in. Gradually it accelerates itself, following the progressive march of the development of the vibrions. The putridity

becomes so intense that the microscopic examination of a single drop is very unpleasant. The fetid odour depends chiefly on the proportion of sulphur the substance contains. The odour is scarcely sensible if the matter is not sulphuretted, as, for example, in the fermentation of the albumenoid matter which water can carry away from the yeast of beer. The same is the case with butyric fermentation; and after my experiments butyric fermentation must, from the nature of its ferment, be considered as a phenomenon of exactly the same order as putrefaction properly so called. Thus we see what happens when putrefaction is in some sort restrained."

"It results from what precedes, that contact with air is not necessary to the development of putrefaction, but that, on the contrary, if the oxygen, dissolved in a putrescible liquid, is not removed by the action of special beings, putrefaction will not occur, as the oxygen would cause the vibrions to perish if they tried to develope themselves."

"I shall now examine the case of free putrefaction in contact with air. That which I have already said might make it appear that it could not take place under such circumstances, as oxygen kills the vibrions which excite it. Notwithstanding this, I shall demonstrate that putrefaction in contact with air is more complete than when it is effected under shelter from air."

"Let us go back to our aerated liquid, this time exposed to contact with air in a wide-mouthed vessel. The removal of the oxygen takes place as previously described. The difference is that the bacteriums, etc., do not perish, but propagate themselves to infinitude at the surface of the liquid which is in contact with the air. They form a thin pellicle, which gradually thickens, falls into rags to the bottom of the vessel, is formed again, and so forth. This pellicle, with which is usually associated divers mucors and mucedines, prevents the solution of oxygen gas in the liquid; and thus permits the development of the vibrio-ferments. For them the vessel is as if closed against the introduction of air. They can even multiply in the pellicle at the surface, because they find themselves protected by the bacteriums and mucors against too direct an action of the atmospheric air."

"The putrescible liquid thus becomes the seat of two kinds of action, very distinct, and which are in relation to the physiological functions of the two kinds of beings that nourish themselves in it. The vibrions, on one hand, living without the aid of atmospheric oxygen, determine, in the interior of the liquid, acts of fermentation—that is to say, they transform nitrogenous substances into more simple, though still complex, products. The bacteriums or the mucors burn these same products, and

bring them back to the simple condition of binary compounds, water, ammonia, and carbonic acid."

"We have yet to distinguish the very remarkable case in which the putrescible liquid forms a layer of slight thickness with easy access to atmospheric air. I shall demonstrate experimentally that both putrefaction and fermentation may be absolutely prevented, and that the organic matter will yield only to the operation of combustion."

"Such are the results of putrefaction effected with free contact with the atmosphere. On the contrary, in the case of putrefaction under shelter from the air, the products of the doubling* of the putrescible matter remain unchanged. This is what I meant when I said that putrefaction in contact with air is a phenomenon, if not always more rapid, at least more complete, more destructive of organic matter, than putrefaction under shelter from air. In order to be better understood I shall cite some examples. Let us putrefy—I employ the word designedly in this instance as a synonym of ferment—let us putrefy lactate of lime sheltered from air. The vibrion-ferments will transform the lactate into several products, one of which is always butyrate of lime. This new compound, indecomposable by the vibrio which provoked its formation, will remain indefinitely in the liquid without any change. But repeat the operation in contact with air. As fast as the vibrion-ferments act in the interior of the liquid, the pellicle on the surface gradually and completely burns the butyrate. If the fermentation is very active this combustion is arrested, but entirely because the carbonic acid that is disengaged hinders the arrival of atmospheric air. The phenomenon recommences as soon as the fermentation is finished or lessened in rapidity. It is precisely the same if we cause a naturally sweet liquid to ferment under shelter from air, the liquid is charged with alcohol almost indestructible; while if we operate with contact of air, the alcohol after being acetified is burnt and transformed entirely into water and carbonic acid. Then the vibrions appear, and in their suite putrefaction, when the liquid only contains water and nitrogenous matter. At length in their turn the vibrions and the products of putrefaction are burnt by the bacteriums or the mucors, of which the last survivors incite the combustion of their predecessors, and thus is accomplished the return of the organized matter to the atmosphere and to the mineral kingdom."

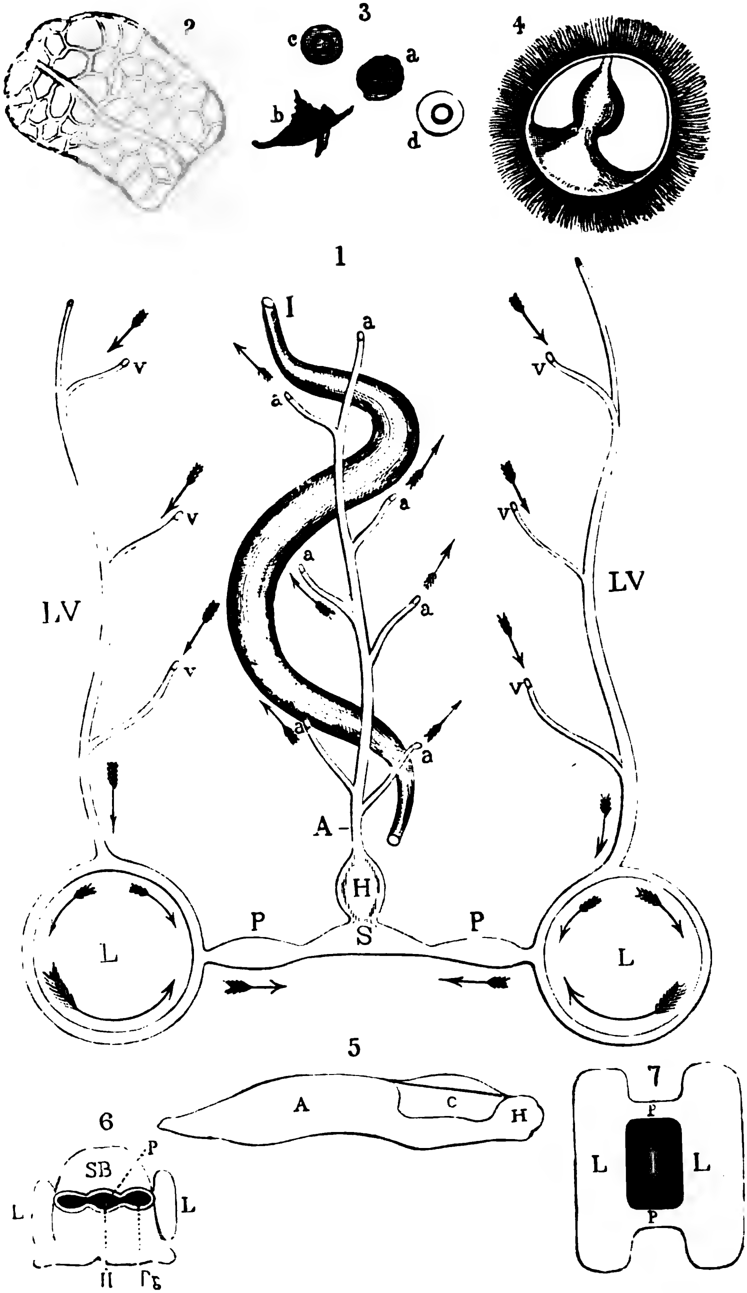
"Let us now consider the putrefaction of solid bodies. I have recently shown that the body of an animal is, under

* "*De doublement de la matière putrescible.*" Pasteur means the products of the putrefactive fermentation, which he has described as complex, though more simple than the original substances.

ordinary circumstances, shut against the introduction of the germs of inferior beings; consequently putrefaction begins first at the surface, and afterwards reaches the interior of a solid mass. If a whole animal is left after death either in contact with, or sheltered from, air, its surface is covered with germs of inferior organism which the atmosphere has conveyed. Its intestinal canal in which fæcal matters are formed is filled not only with germs, but with fully developed vibrions, as Leewenhoek perceived. These vibrions are much in advance of those on the surface of the body. They are adult individuals, deprived of air, bathed in liquids, and in process of multiplication and function-performance. It is by their aid the putrefaction of the body begins, which has only been preserved up to that time by life and the nutrition of its organs."

After a few observations M. Pasteur declares his conviction that "neither in their origin nor in their nature is there any resemblance between putrefaction and gangrene," and he adds, "instead of being a putrefaction properly so called, gangrene appears to be that condition of an organ in which one part is preserved in spite of death from putrefaction, and in which the liquids and solids act and react chemically and physically beyond the normal actions of nutrition."

We shall only remark upon this very important and interesting paper that few English microscopists adhere to Ehrenberg's notion, which is adopted by M. Pasteur, that vibrions are *animals*. On the contrary, Drs. Arlidge, Williamson, Burnett, and other authorities, agree with Cohn that they belong to the vegetable kingdom, and are in many cases transitional forms of Algæ.



Circulation and Respiration of Slug.

THE LUNGS, HEART, A THE

BY HENRY

Professor of Physiology in Q

(*With a T*

We all know the man has lu circulates in his body, but th ry much astonished to learn t is a heart and lungs also, teries and veins, and is prop pulsations of the heart.

I hope to show in the pres question has all the organs t explain to you the steps by wh ledge on your own account, sh regarding *my* statemen sting to be informed th and that another is know more satisfactory to be able to t and, and demonstrate for on falsity of an author's statemen well known for his original rese some particular assertion, it by conclude that that assertion is tr serving natural objects may be owing to some fo those things which they had as important but wh speculations. Hence, pointing out to you the to satisfy yourself regarding servations which I have here committed

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THE LUNGS, HEART, AND BLOOD-VESSELS OF THE SLUG.

BY HENRY LAWSON, M.D.,
Professor of Physiology in Queen's College, Birmingham.

(*With a Tinted Plate.*)

WE all know that man has lungs and a heart, and that the blood circulates in his body, but there are many of us who would be very much astonished to learn that as low an animal as the slug has a heart and lungs also, and that its blood circulates through arteries and veins, and is propelled through the former by the pulsations of the heart.

I hope to show in the present article that the mollusk in question has all the organs to which I have alluded, and to explain to you the steps by which you may arrive at the knowledge on your own account, should you be inclined to exhibit scepticism regarding *my* statements and assertions. It is very interesting to be informed that one creature possesses one gland, and that another is known to have another, but it is vastly more satisfactory to be able to take one's scalpel and forceps in hand, and demonstrate for one's self the accuracy or it may be the falsity of an author's statements. For although an anatomist, well known for his original researches, may pledge himself to some particular assertion, it by no means follows as a logical conclusion that that assertion is true. The most skilled in observing natural objects may be occasionally deceived, or may be so blinded, owing to some foregone deduction, as to see only those things which they had anticipated, to the exclusion of others as important but which do not touch immediately on their darling speculations. Hence, as I have just mentioned, I propose pointing out to you the mode which you must pursue in order to satisfy yourself regarding the truthfulness of the observations which I have here committed to paper.

We have to study two great systems in the economy of the slug—the respiratory and circulatory; and as facts are of very little value unless we associate them with ideas, let us ask what is the use of a respiratory system? The object of a lung is to expose the blood freely to the influence of the air. The function consists in certain operations going on simultaneously in the blood and atmosphere, and which result in the purification of the former.

The blood has two important duties to discharge.

1st. It absorbs from the stomach the valuable portions of the food, which it carries to the different tissues in order to repair them.

2nd. It abstracts from the tissues the refuse matter of the

old structures, and carries it away to the various sewers (glands, etc.), of which the lung is one.

This refuse or effete material is of many sorts, each of which is removed by a separate channel, thus:—Urea is got rid of through the kidneys, bile through the liver,* and lactic acid through the skin. In the lung, the foul air (carbonic acid) is discharged, the oxygen of the fresh air is taken in, and the blood is altered in properties and constitution.

Having your slug fixed in the way described in a former number,† seek the pulmonary opening. This is placed on the right side, in the middle lateral line, and at about half an inch from the right upper tentacle. It is of an elliptical, or rather of a double wedge shaped outline, and may readily be distinguished whilst the animal is breathing, owing to its snow-white lining, which is now and then everted, contrasting markedly with the dark black hue of the outer skin. Before you begin your dissection, it will be as well to map out distinctly the extent of the lungs, which may easily be done as follows;—Take a thin glass tube, slightly drawn out at one end, and insert it into the orifice, which, with a little care, you may easily do; then blow the air somewhat forcibly from your mouth, and the lungs of both sides will become visibly inflated, together with the passages of intercommunication, in this manner indicating with clearness the exact limits of the pulmonary system.

Having formed a general notion of the whereabouts of the lung sacs, next place the point of your curved knife within the orifice, and keeping the blade as horizontal as possible, cut steadily backwards, and in a line parallel with the middle lateral plane till you reach the membranous constriction which separates the thorax from the abdomen; at this partition the lung ends posteriorly. As yet you have only exposed the right lung, but since it communicates with its fellow of the opposite side through two distinct channels, by laying them bare, you may then come upon the left sac.

Place your long-bladed scissors in the hinder passage (which lies quite in front of the constriction referred to, and in the transverse plane), and with the blades as close to the partition as possible, cut from right to left through the integument. You now reach the left lung sac, but before you can examine it you must make two other incisions.

1st. Cut from behind forwards, parallel to your first incision, till you arrive at the anterior end of the sac.

* The bile is not entirely worn-out matter, for although if retained in the system (of man), it tinges the skin and poisons the brain, producing jaundice, it is in some unknown manner subservient to the ends of digestion.

† *Vide* INTELLECTUAL OBSERVER, for May, 1863.

2nd. Cut transversely from left to right through the front channel of communication, and parallel to your second incision, till you reach the remnant of the pulmonic aperture.

By these four incisions you have laid open the lungs, which present themselves, not as a ring,* surrounding the undivided central portion (the heart and shell-bag), but as two distinct pouches of oblong form. These pouches enclose between them the heart, heart-gland, and the shell-bag, and are shut off below, behind, and in front, by folds of thin lining membrane, which pass from the inner surface of the general skin of the body. Each division measures about half an inch in length, and is somewhat more than a quarter of an inch deep; the width is inconstant, depending, as it does, upon the condition of the body as to elongation or contraction. The walls of the lungs are composed of the general skin, which has within it a snow-white lining. This latter is the true respiratory surface. Blood-vessels cannot be said to ramify in it, but it is literally tunnelled by passages which interlace in the most intricate manner, forming a network in which the blood is exposed to the influence of the atmospheric air, introduced through the lung-opening. The blood which circulates in the lungs is not sent there directly from the heart (as is the case in man), but is carried to these sacs by two great veins, one of which lies on each side of the body, and, by the aid of numerous branches which contribute to form it, conveys the vital fluid from the abdominal cavity to the pulmonary networks. The course which the blood takes in traversing the lungs we shall investigate under the head of

ORGANS OF CIRCULATION.

In vertebrated animals the vessels through which the blood travels, in "going its rounds," are of three kinds:—

1st. Thick-coated vessels, which bring the blood from the heart.

2nd. Microscopic channels called capillaries,† which are present in almost every tissue of the body.

3rd. Thin-coated tubes with valves, which carry the blood from the capillaries to the heart; these are called veins.

Formerly, when the habit of drawing analogies between vertebrates and invertebrates was more frequent than it is in our day, it was supposed that in all gastropods what was termed a *complete* circulation existed; that is to say, the blood

* Von Siebold and others have stated that the lungs in this creature are of an annular character. I leave the reader to judge between myself and so learned an anatomist.

† So called from "capilla," the Latin for a hair, but they are very much smaller than any hair, and clusters of them placed together would not be as thick as a human one.

passed from the heart into arteries, from these into capillaries, and from the latter into the veins, and thus returned to the heart again. This view, as we shall see presently, was erroneous. It was at first held most persistently by Cuvier,* who, although he had demonstrated the absence of capillaries in the genus Aplysia (sea-hare), contended, nevertheless, that this was but an exceptional instance, and that for the most part head-bearing mollusks had a complete circulatory system. In this century the most formidable controversy upon the question has taken place between M. De Quatrefages and M. Souleyet; the former maintaining, correctly enough, that in these beings the circulation is *not* perfect, and the latter asserting with equal determination that it *is* perfect.†

I have paid no inconsiderable attention to this subject, and I believe I have succeeded in showing the course of the circulation, and also the absence of capillary vessels.‡ The blood having been expelled from the heart (Fig. 1), passes through the first great artery (aorta), and from it through its various divisions and sub-divisions till it reaches the stomach, intestines, head, liver, etc., etc., and at last arrives at the ends of the arterial vessels;§ and as these are quite open, the fluid escapes from them. What then becomes of it? It flows into the great abdominal cavity—that sac formed by the integument in which are placed the important organs, which constitute the great bulk of the animal. Here it bathes the digestive tube and the great glands, and sooner or later is admitted into the veins, and travels to the lungs. The general veins, like those of the lungs, are channels grooved in the skin, and are not distinct vessels, such as the arteries. They ramify in the abdominal integument, springing on either side from a large lateral branch which commences at the tail and terminates in the lung, and by which all the blood that had been thrown out from the arterial tubes is re-collected and carried to the respiratory surface.

At this point difficulty has been invariably experienced in ascertaining the precise direction in which the stream of blood flowed—one side contending that of the entire current, a portion passed to the so-called kidney, while the remainder flowed through a special pulmonary vessel to the heart; the other, that the blood was poured at once into a sinus or lacuna. Both these ideas I believe to be incorrect, the more so as I

* *Règne Animal*, "Mollusques," p. 50.

† *Comp. Rend.* xix. and xx.

‡ *Quarterly Journal of Microscopical Science*, January, 1863.

§ Professor Milne Edwards says, that in most gastropods the aorta ends in a sinus (or cavity) containing the brain, gullet, and salivary glands, vide *Frorieps Neue Notizen*, xxxiv. pp. 80, 260. This is not the case in the slug.

have been unable, after the closest scrutiny, to detect any separate pulmonary vessel capable of conveying the blood to the heart, and as I am well aware that the relations and use of the would-be kidney have been much misunderstood. Ere we proceed further I must show you how to expose the heart, heart-gland, and blood-vessels, which we are about to enter upon the study of.

When dissecting the lung, you left untouched a sort of island of skin and flesh, which was in the living animal surrounded by integument. This square patch is a sort of house with two stories, an upper and lower; the former contains the remnant of the shell, and is named the shell-bag; the latter contains the circulatory organs. Carefully, with your curved scissors, remove the shell-bag and the adjacent loose tissue, and you will see a ring of brown gill-like plates, and within this ring the little conical heart of the slug, the whole being covered in by a beautiful gossamer-like membrane, which is so exquisitely transparent that you can watch all the movements of the heart and vessels.* You will now observe that the blood travels from the lungs towards the pericardial gland (brown ring) in the directions shown in Fig. 1.

Having been poured from the great pulmonary vein of each side into the numerous branches of the lung network, and by this means exposed fully to the action of the atmospheric air, the blood flows in two principal directions, according to the portions of the network which it has traversed. Thus that which had passed downwards from the great veins, and had descended to the bottom of the sacs, now *as*cends and reaches the border of the pericardial gland, and that which had travelled to the superior portion of the lung *de*scends and meets that which has journeyed upward, at the same plane (border of pericardial gland). This process goes on in both lung sacs simultaneously; and we find that all the blood which has been purified in the respiratory organ must flow to the border of this gill-like gland, prior to its entrance into the heart. Next, the blood flows in a perfectly centripetal manner through this gland till it reaches its inner edge. This is hemmed round by a transparent membrane, which in the posterior half constitutes a kind of semi-canal, and in front expands in the form of a sextant, as shown in the diagram (fig. 4). Into the folds, then, of this double membrane (half canal, half bag) the blood is poured. Now the narrow extremity of the sextant-shaped bag opens directly into the base of the heart, there being a small fold of membrane placed in the aperture, which plays the

* If the animal be not dead the heart may be seen with the greatest distinctness, and its pulsations counted. It would be difficult to conceive of a prettier object than the circulatory organ when in this condition.

part of a valve. Hence the blood flows freely into the heart from this membranous cavity or sinus, as I have termed it.* By the contraction of the heart it is forced onwards through the aorta and arteries, and eventually reaches the different organs of the body. When the heart contracts there is a tendency to expel the blood in two directions—forwards through the arteries, and backwards into the sinus—but here the valve comes into operation, and by preventing the backward flow, allows the circulatory organ to employ all its power in the propulsion of the fluid.

The heart is a thin muscular bag, of a triangular or rather a pear-shaped outline, and a delicate flesh-like colour. It is situate in the region of the thorax, is surrounded by the pericardial gland, and is bounded above and below by transparent folds of tissue. It lies in an oblique plane, its apex pointing backward and to the right, and its base in the opposite direction, and measures about a quarter of an inch in length, and one-sixth or thereabouts in width. The heart has been incorrectly described as consisting of two cavities—an auricle and ventricle. It is not divided by a partition of any kind, and is to all intents and purposes a simple sac, composed of numerous interlacing muscular fibres of the unstriped variety; these are filled with long spindle-shaped endoplasts,† containing clear well-marked nuclei. If we examine the inner surface of the heart with an ordinary pocket lens we may perceive a very peculiar muscular arrangement. From two centres situate in the lateral walls of the organ, sets of muscular chords pass out in a radiating manner and ultimately become continuous with the ordinary fibres; in this way they form two stellate elevations, which *possibly* serve the same purpose as the "*carneæ columnæ*" of the heart of man and mammalia.

The pulsations of the heart amount to about twenty in the minute, each contraction being followed by a dilatation, and then a period of repose occurring, during which the membranous sinus is being gradually filled. When a dilatation occurs, the sinus, owing to the tendency to form a vacuum, is instantly emptied, then a contraction following, the blood is sent into the arteries, the sinus is refilled, and everything goes on as before.

The arterial system, or series of tubes which conveys the blood *from* the heart *to* the body generally, consists of the aorta, with its branches and their numerous divisions. The aorta arises from the apex of the heart, and after attaining a length of one-sixth of an inch divides into two trunks, each of which has a calibre of about $\frac{1}{40}$th of an inch; these remain in company

* *Vide Quarterly Journal of Microscopical Science, loc. cit.*

† Cells of the older writers.

till they reach the adjacent intestinal fold, and then separate. One branch passes toward the head, running in its course beneath the reproductive organs, heart and pericardial gland, and parallel with the rectum, and finally becomes lost in supplying branches to the gullet and organs of the head. The other travels backwards toward the stomach, giving off about twenty branches to the intestine and liver, the twigs to the intestine being given off distinctly and passing over the hepatic organ to their destination. These vessels divide and sub-divide extensively, and form the most beautiful ramifications upon the digestive canal, which they contrast with forcibly, being of a snow-white colour, whilst the intestine owing to its vegetable contents is usually green. On arriving at the stomach the main artery bifurcates (divides in two), one branch passing backwards to supply the egg-gland and tail-lobe of the liver; the other being destined for the stomach and left division of the liver, upon whose inferior surface a series of very pretty arborescent vessels may be observed.

I believe that the view of Erdl,* that a network of capillaries exists, is erroneous.

1stly. Because even the most careful scrutiny fails to detect anything in the shape of capillaries.

2ndly. Because the rootlets of the veins terminate *undoubtedly* in apertures.

3rdly. Because the whole of the organs in the hinder part of the body are free, that is to say, unattached to the general integument in which the veins lie; and as the arterial supply is almost exclusively to these organs, had there been any system of canals intervening between them and the skin, the latter and the viscera would be adherent to each other in this locality. The arteries are composed of nucleated muscular fibres, which embed in their substance a large quantity of carbonate of lime (chalk) in the granular condition, which gives the vessels their peculiar white colour. Professor Von Siebold† asserts that the ends of the arterial tubes are built up of chalk particles only, without a trace of muscular fibre. I have been unable to confirm this assertion; in all the specimens which I examined (where it was possible to form a conclusion) I most distinctly observed, mingled with the granules, long nucleated endoplasts.

The blood of the slug is colourless, but it is not as some might imagine, a homogeneous fluid. It is composed of a transparent liquid, consisting of water, a small quantity of albumen, and a *trace* of fibrine. This fluid contains in it certain bodies of a spherical form termed corpuscles, and these latter

* *De Helicis Algiræ.* Bruxelles.

† *Vide* "*Vergleichenden Anatomie.*" Section—*Cephalophora.*

are of two sorts;* one opaque and granular, the other clear and possessed of a nucleus. The corpuscles may be obtained for examination by pricking the sinus of the heart and placing a drop of the fluid, which exudes, upon a glass slide. If now we remove this and examine it with a power of four hundred diameters, we shall see the two varieties. It is possible that at first we may see only the opaque forms, but by treating them with water we render them transparent, and their nuclear and other contents quite perceptible, as shown in the plate, fig. 3. It is strange that although colourless blood is the rule among the gastropoda, the planorbis has a circulating fluid of a reddish hue.

The peculiar glandular apparatus which surrounds the heart, and which I have called the pericardial gland, has been called the kidney by anatomists, and writers upon this subject. It is exceedingly wrong to style an organ a kidney merely upon a vague supposition that its function *may* be that of an urine gland, when its structure and position do not seem to support such a view. Yet this is what has been done by Cuvier, Jacobson, Müller, Siebold, and a host of others. Let us see what grounds there are to support this opinion.

In the urine of most animals is found a peculiar insoluble substance termed uric acid. Now, chemists have discovered that where this is acted on by aquafortis (nitric acid) and hartshorn (ammonia) a characteristic red colour is produced, and since there is not any other substance (?) capable of being affected in a similar manner, it follows, logically enough, that if in this organ of the slug we find a material whose chemical reaction with aquafortis and hartshorn is similar to that of uric acid, that material must be uric acid. Jacobson† asserts most positively that he has found a deposit in the heart gland of the slug which gave rise to a reddish stain when acted on by aquafortis and subjected to the fumes of hartshorn—hence the deduction.

I have made a series of experiments upon the same subject, and have invariably found—

1st. That the stain was not of the ordinary red hue, but of a *dirty* reddish brown.

2nd. That it was produced by the aquafortis alone without the employment of the hartshorn, and

3rd. That the same stain was produced when portions of the liver had been placed under similar conditions.

* This was first distinctly indicated by Mr. Wharton Jones in his admirable memoir in the *Philosophical Transactions* for 1846; for though Leydig described two forms of corpuscles in his admirable memoir, *Ueber Paludina Vivipara*, yet he was ignorant of their developmental relations to each other.

† *Meckel's Archives*, VI., p. 370. 1820.

Which three results are quite sufficient in themselves to show that there is not much reliance to be placed in the statements of those who assert that the gland is a kidney.

Again, if this structure really fulfilled the office of an urine gland it is evident that it should have attached to it some channel through which the excrementitious fluid might be carried out of the body. Even the opposite side admits this. Here, however, we differ. Siebold, Cuvier, Müller, and others maintain that there is a tube connected with the gland, and opening near the lung aperture. I, on the other hand, contend that no such canal is present. I have dissected many specimens with the hope of discovering something of the kind, but I have invariably failed to observe it; and I can only account for the mistaken observations of such distinguished naturalists by assuming that in emaciated German and French slugs the end of the intestine (which pursues exactly the route of the supposed duct,) has been looked on as the canal of the gland.

The pericardial gland is of a dark reddish brown colour, and measures from side to side (including the heart and sinus) more than half an inch. It is made up of a great number of lamellæ or plates lying against each other, like the leaflets of a fish's gill. Each of these examined under the microscope appears to be composed of numerous irregular vacuoles, containing within them solid, round, opaque, incompressible nuclei. Passing between the plates may be observed hundreds of blood vessels journeying from the lung to the sinus, and on their passage giving off several branches, which wind about the vacuoles and anastomose frequently. I cannot see that there is any *necessity* for supposing that a slug has a kidney at all. But even did I suppose the creature possessed of such a commodity, I cannot conceive why I should pitch upon the pericardial gland as the organ most likely to subserve the function, simply because one of the compounds found in human urine was discovered (or *said* to be discovered) here also. As well might a person ignorant of anatomy, contend that the skin of man was the human kidney, because there is undoubted proof of the statement that urea (a constituent of the renal secretion,) is thrown out from the body in the perspiratory fluid. So long as scientific men frame generalizations upon such vague and careless observations as those I have alluded to, so long will comparative anatomy be uncertain and unreliable. If the reader will take the trouble to investigate the matter for himself he will then ascertain how loosely many of the conclusions of comparative anatomists have been formed, and how important it is to accept no statements as *truths* until they have been verified by personal research.

EXPLANATION OF PLATE.—Fig. 1.—Plan of the circulation; the arrows indicating the direction of the currents; *ll*, the lungs; *pp*, the pericardial gland; *s*, the sinus; *h*, the heart; *a*, the aorta; *aaaa*, the various arterial branches; *i*, the digestive canal; *lvlv*, the great lateral veins; *vvvv*, their branches. Fig. 2.—Inner surface of the membrane of the lung, showing the network of blood-vessels. Fig. 3.—Blood corpuscles; *a*, opaque and granular; *b*, with projecting processes; *c*, the nucleus faintly seen; *d*, the nucleus distinctly seen. Fig. 4.—The heart and sinus, surrounded by the pericardial gland. Fig. 5.—Imaginary longitudinal section in the vertical plane of the animal; *h*, the head; *a*, the abdomen; *c*, the cavity which contains the heart, sinus, gland, and shell. Fig. 6.—Imaginary vertical section in the transverse plane; *ll*, the lungs; *sb*, the shell-bag; *p*, the pericardium; *h*, the heart; *pg*, the pericardial gland. Fig. 7.—Plan of the pulmonary organ; *ll*, the lung sac of each side; *pp*, the passages of intercommunication; *i*, the isolated patch, containing the heart, sinus, shell-bag, etc., etc.

AILSA CRAIG AND ITS BIRDS.

BY ROBERT GRAY,

Secretary to the Natural History Society of Glasgow.

IT is hardly necessary to dwell upon the general features of this remarkable rock, for, like other isolated rocks of the same character, it presents scenes which have often been described—steep precipices towering on all sides; high ranges of fractured pillars, sometimes overhanging and shadowing the deep; cliff seeming to rise above cliff, their massive walls streaked with endless rows of soldierly sea-fowl; the whole island, from its solitary position, rising upon the view in "unattended majesty," and impressing the beholder with a feeling of awe.

When nearing it in calm weather no one can fail to be struck by the grandeur of its precipitous cliffs, reaching 1200 feet above the sea; the eye at once comprehends its vastness, owing to what Dr. M'Culloch has called its "sudden and unexpected magnitude," especially when the summit is invested with floating mist; and while speculations naturally force themselves upon the mind of the spectator, whether geologist or bird-hunter, regarding the time when in awful convulsion the great mass first upheaved its "broad bare back into the clouds," it must be confessed its present aspect is uncommonly peaceful, forming a scene, indeed, in which are combined many

elements of beauty. The air-worn precipices, as seen about sunrise, when the long yellow rays come streaming across the water, lighting up the perches of the sea-fowl, are gleaming with innumerable birds; and, as these pure white figures contrast with the rusty background, every object tells in the picture. From base to peak these cliffs are occupied by long lines of guillemots and razorbills, and huddled groups of gannets and kittiwakes; myriads of puffins stud the fallen fragments reaching to the water's edge, a curious effect being added by the tree mallows, throwing a purple tinge on the face of the rock; while over all, the green slopes which carry the eye to the cloud-capped summit are covered with the greater sea-gulls—these splendid birds appearing, from a distance, like large white flowers amongst the grass.

Seen at break of day, therefore, few objects could be more impressive to a naturalist than this prodigious bird-hive, where many thousands of its feathered natives are in sight at one view, before the masses break up and wing their flight to the surrounding sea: it can only be exceeded at sunset, when these multitudes return for the night, the craig being then invested with a solemn splendour which words can never do justice to.

Yet ninety years ago Pennant, who landed upon Ailsa in the month of June, called it a scene of horror, and wondered why thrushes could exert their melodies in such a place as cheerfully as they did in the groves of Herefordshire; overlooking the fact that these were Ailsa-born throstles, shouting with glee, and making the columns and halls of their rocky home resound with a mavis' welcome!

On the south-west side of the rock the tidal waves have rolled and polished the stones so as to form a rough kind of beach, on which a landing can be safely effected. The visitor is here welcomed by the keeper and his dogs—a group not the less picturesque by a continued residence, summer and winter, in their lonely kennel. One cannot help thinking of this modern Crusoe being troubled occasionally in his sea-girt abode by the waves in stormy seasons roaring to one another in the night-time, and flinging themselves with a crashing sound at his very door; but in answer to our inquiry, he declared that once only did he feel solitary, and that was when something went wrong with his eight-day clock; the familiar ticking having ceased, he became conscious, he said, of the "noise outside."

Proceeding by a rugged path along the base of the cliffs, it is possible to make a circuit of the island, a task, however, by no means easy to accomplish, the distance being computed at three miles, over a mass of angular rocks, which have fallen from the upper ridges, and now lie piled in terrible confusion to a height, in some places, of 300 feet. As the road ceases

altogether about half way, any one desirous of completing the journey is compelled to surmount the difficulties of the adventure by indulging in a series of most undignified attitudes. The most prudent course the visitor can adopt is to pause for a time at the safest point of observation, where he will obtain a view of the basaltic pillars, one of the grandest ranges in Britain. These stupendous columns attain an elevation of 400 feet—a height six times greater than the famous pillars of Staffa. Many of these gigantic blocks have become partially disconnected, and look as if ready to fall at the slightest touch. The extraordinary accumulation of fallen rocks already spoken of is the result of such blocks giving way; and as, throughout its whole extent, this mass has now become the chosen abode of countless puffins, we may imagine the singular spectacle afforded by a legion of these birds pouring out of their holes when a few tons of trap happen to fall upon their territories.

A steep and somewhat dangerous footpath forms the ascent to an old castle in ruins, the surface beyond that elevation being irregularly covered with immense pieces of rock, which lie scattered in the wildest confusion. The hollows are filled with plants of a monstrous growth, tall, fierce nettles, and umbrella-like blades, amongst which the tourist, as he brushes his way to the summit, stumbles at intervals, and not unfrequently sinks out of sight, getting wedged in the most awkward postures in the cold embrace of these boulders. The only satisfaction, while so situated, is to listen to the tinkling sound of a miniature river which has its source at a marshy hollow some distance above, and which now runs fresh and clear, singing its quiet tune in strange contrast to the noise of the great reservoir below; but the best reward of all awaits those who have patience to toil up to the Cairn, as the magnificent view of the Frith of Clyde is one of memorable interest.

Of the various birds to be found upon this "lone isle" (there are upwards of forty observed as regular visitors), by far the most numerous is the puffin (*Mormon fratercula*). On nearing the craig in a boat, this comical species is the first to make himself known by rising on all sides out of the water; he looks at you for a second or two, then with a diverting turn of his little fat body, he throws up his painted heels and plunges out of sight. It is only on the rock itself, however, that a near acquaintance can be made with the puffins, for the ornithologist has but to sit down anywhere near their burrows, and keep the peace, when the Mormons will show their confidence by alighting in hundreds within a few feet of the spot he occupies. There is, it must be confessed, a risk of censure incurred while speaking of bird flights darkening the air, and making a noise like the rushing of wind, yet the scene I wit-

nessed last summer could not well be described without employing these terms. It was about nightfall, in the month of July —a favourable time, most of the young puffins being fledged and congregated before taking leave. All the birds were in from their fishing expeditions, and the entire population therefore was nearly in sight at one view. As soon as the alarm became general, causing flock after flock to rise, the mass of birds looked quite impenetrable, the noise of their wings resembling thunder more than anything else it could be likened to. These swarms completely bewildered me, and as the birds could have been touched by merely stretching out the arm, I scarcely knew for a time where to turn, or how to get back to the *open-air*. The idea of being confined within living walls at such an hour was suggestive of a somewhat dangerous roosting-place, and as for thirty minutes at least these legions beset my whereabouts, I was really glad when they came to their senses, and began to settle. Using every precaution, I crawled towards the edge of a precipice, and crouched among some broken peaks, on the other side of which the puffins were beginning to alight. Every available spot was immediately covered by some thousands, each bird touching its neighbours' shoulders; it would have been impossible to insert one's hand anywhere, they sat so close. Having a stick at my side, I cautiously thrust it past a screening rock; and by bringing it into rough contact with the nearest one, the sensitive fellow retaliated on his neighbour, which in its turn directed its revenge just where it could most conveniently strike. By this time the stick was offending the rump of another Mormon, till by the clatter of bills I learned that the whole settlement was in an uproar. On starting up I saw that those nearest the bottom of the slope were being pushed over the cliff; but the impression was but momentary, for at once the entire flock rose, and after wheeling seaward in a beautiful curve, they returned and repeated the movement again and again, till I left.

The puffin arrives on the west coast of Scotland in February, sometimes in January. On the craig itself it is so regular in its appearance and time of leaving, that no dates could be fixed with greater certainty. Whole companies set to work at once, and prepare their burrows, which, in exposed places, much resemble rabbit holes. From these strongholds it is almost impossible to dislodge them by any other means than a little terrier trained as a puffin catcher. The keeper having a dog of this kind on the occasion of my last visit, I was greatly amused to see the little fellow, after having pushed his way along the dark passages, shuffling out of a burrow with half-a-dozen or more puffins dangling on different parts of his body. An angry puffin, like a bulldog, never thinks of quitting its hold—a habit

which makes the shaggy coat of a terrier extremely serviceable as a bait. When the young are hatched, they are abundantly supplied with sand eels and sprats, caught by the old birds and brought to the burrows, not singly, but in quantities. Having for many hours at a time watched, I may say, thousands of puffins carrying their prey to the rock, I have been continually puzzled to find out how it was possible for them to bring so many fishes at a time, seven or eight being a common number. They are held by the head, the bodies hanging on each side of the bill; and sometimes I have knocked down a bird while carrying eleven sand eels, five ranged on one side and six on the other. Their mode of catching so many such slippery creatures consecutively without mutilating any other part but the head, has not yet been noticed, nor can the singular feat be satisfactorily accounted for.

Curious varieties of plumage occasionally occur among these birds. I have examined two which were killed by the fowlers a few years ago; one being of a rich cream colour and spotless, the other as black as a negro. The last named variety is seen upon Ailsa almost every summer, and has an uncommonly ludicrous appearance.

The solan goose (*Sula alba*) is not so numerous upon Ailsa as the puffin, but as the number of this species on the Bass Rock has been computed by qualified judges to be from ten to twenty thousand, it is not too much to say that there are at least as many on the craig. When two or three thousand are seen fishing together there could not be a more extraordinary ornithological spectacle. Early in February they have been observed —many thousands in one flock—off the village of Ballantrae, assembling over a shoal of fishes, and precipitating themselves from a height with a loud splash into the sea in pursuit of their prey; while on the east coast, in the month of July, I have seen them in prodigious numbers plunging for herrings in Belhaven Bay within sight of the Bass Rock, their favourite nestling place. Small straggling parties are often seen at some distance from land diving for mackerel and other fish, on which occasions they sometimes mistake their object and forfeit their lives. In several instances they have been observed returning to Ailsa Craig with a gurnard sticking in their throats, the fish in each case having been caught in the usual manner, and hastily swallowed head foremost; but a glimpse of the interior had probably been too much for even a fish's nerves, and had set its *hair on end.* I have examined several dead birds found at the foot of the cliffs, with their last mouthful so firmly wedged as to oblige the use of a knife to cut the spines before the fish could be taken out. But as it is on soft-finned fishes gannets chiefly feed, accidents of this kind are not frequent. When a shoal is discovered they soon

congregate and commence their formidable attack. Select a single bird, if that be possible; he soars but a minute, then with closed wings he poises his body, and goes down like a stone, making the spray break over the spot where he entered. After a few moments' submersion he reappears with a cork-like buoyancy, throwing back his head and gobbling down his prey so hastily and with such voracity, as almost to justify a suspicion that neither the bird nor the fish can benefit much by the transaction.

Having a keen appetite, the solan goose is easily imposed upon. I remember on one occasion fastening, by way of experiment, a fish to a fir plank more than a half an inch thick, and sending it adrift as a lure. It had not been long out till a wandering gannet was seen approaching. Immediately he caught sight of the fish he halted in his flight, and in another moment dashed head foremost with such force as to split the board in two; the bird, harlequin-like, disappearing in the sea as if nothing had obstructed its descent. Often afterwards, on looking at him in my collection, I regretted the unfairness of the poor fellow's capture, a broken neck being the result of his hungry plunge.

Last summer when pigeon shooting at the sea caves south of Ballantrae, one of the boatmen informed me of having assisted, many years ago, in the removal of one hundred and twenty-eight dead geese from a train of herring nets which had been lying at a depth of one hundred and eighty feet. The accumulation of birds in the nets, though sunk with heavy weights, had brought the whole train to the surface, by the buoyancy of their bodies, and attracted the notice of the people on shore; and as the nets contained a quantity of herrings, it was conjectured that the geese had been drawn to the spot by their glittering sides, and been tempted to risk their necks in pursuit.

The guillemot (*Uria troile*) and razor-bill (*Utamania torda*) * breed on the narrow ledges of rock, occupying the entire face of the highest precipices, and presenting, when viewed from the sea, a very remarkable and orderly appearance. They make no nest, but lay their single egg upon the bare ledge, which is seldom more than six inches in breadth, so that each bird is compelled to sit erect when incubating. I have frequently climbed to a height of four or five hundred feet to see the most thickly-populated breeding-place; and having hurled down a few stones to frighten the birds, they all took wing,

* The genus *Utamania*, which was instituted by the late Prince Lucion Bonaparte, when taken in connection with that of *Mormon* or puffin, inclines one to the belief that this distinguished ornithologist had the Great Salt Lake in view when re-arranging his nomenclature.

leaving a most extraordinary collection behind them. The guillemot's egg, which is large and of a handsome shape, is very variable in colour, and of all shades, from pure white to a deep green, many being spotted with fantastic characters and intricate lines, which baffle description or portraiture. The sight of so many, therefore, lying exposed on the bare rock, is one of no common interest. On such occasions many hundreds may be seen uncovered, all nearly touching one another; and when the birds come pouring in towards the ledges, after having been disturbed, each flying directly to its own egg, the infinite variety of colouring, or *private marks*, so to speak, may be looked upon as an all-wise arrangement for keeping up the harmony of the settlement.

The guillemot feeds its young with herring fry, which it brings to the rock half swallowed, the tails being invariably seen outside the bill. The razor-bill is not so industrious, for he may be observed at any hour dozing on his perch, watching the puffins coming to their burrows with a supply of sand-eels; then he sallies out, and buffets the poor *Mormon* till the fishes are dropped, after which he has but to descend, and pick them up. This mid-air robbery is not always so easily settled; for, as both birds are flying with tremendous force—the one hurrying towards the rock and the other launching from it—the collision occasionally causes their death. A few weeks ago a friend, while cruising past the craig, observed a puffin and razor-bill strike each other dead by coming into sudden and forcible collision; but his skipper, probably unaware of the razor-bill's predatory habits, assigned as a reason that they had not *ported their helms*.

On descending on one occasion the grassy slopes, when all the birds were hatching, I approached the perpendicular walls of rock facing the south, on which the guillemots, razor-bills, solan geese, and kittiwakes were sitting in congregations outnumbering all calculation. A party happened to be shooting from a boat close to the base of the cliffs. The birds on the upper shelves, when disturbed by successive shots, resembled a heavy fall of large snow-flakes, the lower stratum of kittiwakes appearing from above as a flickering shower of white particles. Having crept cautiously to the verge of the precipice, and thrust my chin over the sharp edge of a pillar, my heels being meanwhile held by a companion behind, I had a satisfactory view. Looking down four hundred and fifty feet, I observed that the gulls and other birds floating on wing near the water had no particular form, on account of the distance; but there could be no doubt as to the specific identity of the black imps just under my nose. These were young guillemots and razor-bills, the old birds being beside them, anxiously poking out

their necks, and looking upwards with an eye of fear that fairly put me out of countenance. Judging from their expression, it was evident they were not accustomed to such visits of inspection, and their mingled look of terror and perplexity on seeing the apparition was the reverse of complimentary. Under the perch of these odoriferous "children of the mist," other families came in view, lower and still lower, their behaviour and unclean peculiarities being modified by distance, till the eye lost sight of the species, and sea-fowl in general became responsible for the smell and uproar.

When the young of the guillemot are half fledged, the parent birds are seen daily by the keeper taking them down on their backs to the sea, and unceremoniously pitching them off, within a few feet of the water. They have also been observed to seize them by the hind neck, as a cat would do to its kittens, and after a moment's hesitation, launch from their high perches, and descend with an unsteady flutter, till they could drop the young ones with safety.

The fearful discord which prevails on these ledges, when the young are hatched, is not easily described. The guillemots and razor-bills unite in one deafening roar of a peculiar tone, and when that loud groan is past, the harsh cries of the solan geese—bad enough of their kind—are heard as a kind of faint echo. But the noise is only exerted when danger is at hand, for on ordinary occasions the cry of the gentle kittiwake is oftenest heard, especially at twilight, before all becomes hushed. At this hour few localities are more impressive than this solitary rock. I remember one evening in June seating myself on a projecting pinnacle overlooking the sea, where I had partly in view the roosting places of these airy sea-gulls. The sun had gone down behind some loose clouds touching the sea, leaving the sky steeped in purple; the cliffs partook of its hues, and even the birds themselves were coloured for a moment. Looking around I descried a peregrine falcon on his eyrie, the noble bird being close enough for me to see the sparkle of his full black eye. Eagle-like, he sat with his neck drawn upon his shoulders, moving his head with a careless turn to the side. In the next instant he threw a defiant look at the purple spot on the horizon, stedfastly gazing upon it a few seconds, then the glance was withdrawn, and with a shrug he went to sleep. As the gathering shadows now grew deeper, I recollected, what would have occurred to most people in the circumstances, that a knowledge of the best and safest way down the rugged face of the cliffs was of more importance than all the falcons in the world.

The limits of a single article scarcely admit of more than a bare enumeration of the birds frequenting the island; but as

some of these are deserving of more than a passing notice, it may not be out of place to record their occurrence. Among the raptorial birds, the most distinguished visitors (for they no longer breed there) are the golden and white-tailed eagles. These are chiefly seen in autumn, and are supposed to be attracted to the place by their chances of subsisting upon the entrails of rabbits, which are at that season killed by the tacksman, and disembowelled previous to being sent on shore. The peregrine falcon, which is not uncommon, still breeds there, and from his great powers of flight regales himself and young with prey not obtainable on the rock, though the supply is ample. The kestrel, the white owl, and short-eared owl are also natives of the rock. The raven and carrion crow, though systematically shot at, maintain their ground, and bring up their families upon the eggs and callow young of the sea-fowl, long after they have quitted the nest. The corn-crake is occasionally seen with its brood, and the thrush and blackbird both build their nests in the old castle ruins, and among the rocks, at an elevation of 500 or 600 feet. The wheatear is a familiar tenant, and the snipe and woodcock are both common at certain seasons.

Of the gulls there are found breeding on the grass-covered summit five or six species—the kittiwake being, perhaps, the most numerous. The greater and lesser black-backed gulls are also abundant, as well as the common gull (*Larus canus*), and the herring gull, all of which keep within their own territories, the sanctity of which, however, is occasionally outraged by their piratical visitors the skuas. The Iceland gull is the rarest of the family; it is, however, seen in small numbers every summer, and is well known to the keeper. On warm summer evenings I have observed this bird feeding after dusk; and during the day, indeed, it is constantly dozing upon rocks at the foot of the craig, near the water. The ringed guillemot (*Uria lachrymans*) is not uncommon. I have never had any difficulty in obtaining this species from the keeper, who goes in search of it when wanted, and selects his bird, cleverly snaring it with a hair-noose on the end of a pole. The little auk (*Mergulus alle*) has been seen in summer, and the storm petrel breeds under the loose stones at the base of the cliffs. On dull days I have seen the bird issuing from these retreats at mid-day, following our boat two or three miles towards the mainland.

NOTES ON THE NATURAL HISTORY OF THE NATTERJACK.

BY JONATHAN COUCH, F.L.S., ETC.

THE Natterjack is a kind of toad, the existence of which was not known in the British islands until it was made known by Pennant, and to him the information was communicated by Sir Joseph Banks. But there was scarcely anything given of its history or manners. Pennant says that it frequents dry and sandy places, but it is known to the writer only as it is found in places much the opposite of this; although the difference may arise only as its residence and habits are affected by the change of seasons; or by the influence arising from the impulse to deposit its spawn in a congenial situation, which within our observation has only been in pools of rocks so close to the open sea as to appear to be every instant exposed to be broken in upon by salt water. At the most a foot or two of the bare rock is all that lies between the favoured situation and the open sea, so that a little roughness of the waves appears to be at any time sufficient to throw the sea into the place; and in some instances it was noticed that there were pools tenanted by the rockgoby, a fish which must have entered them from the sea, which lay on the same level with those which were occupied by the natterjack. But it was a subject of surprise that the latter could have been able to enter the pool, in consequence of the almost inaccessible situation of the place to such a creature from the land. On closer examination, however, it is constantly to be observed that these selected pools are in a damp place, where a draining of fresh water from the more elevated cliff is constantly dribbling into them; so that the water in which the spawn is deposited is but little, if at all brackish. Natterjacks make their appearance in these situations about the end of March, or at the early part of April; and it appears that in habitually selected spots they come all at once, and without loss of time they begin to perform the functions which have brought them together. This early proceeding is the more immediately necessary as there is scarcely any shelter in the place by which to conceal themselves or their actions; for the water is too fresh for the growth of seaweeds, and too bare to permit plants which might grow in fresh water to establish their roots. In consequence of the exposed situation of these places of resort it sometimes happens that these unprotected animals are destroyed by ignorant persons, who have thought their slaughter a meritorious act.

The shedding of the spawn is probably accomplished in the night, and seems to be effected with considerable labour, and

also to occupy a considerable length of time in the performance. From some circumstances also which attend the proceeding there is reason to believe that it is performed in a different manner from that by which this function is executed in the common frog; and if so, it seems to follow that the fertilization is accomplished while the ova are yet in the body of the parent. Thus in one instance a couple of females without a male were in occupation of a pool in the rock, in which fortunately for them some roots of a flag remained from a former growth, and which, although adhering to the bottom, remained otherwise exposed. To these the long strings of spawn were attached. The arrangement of the grains being alternate in two rows enclosed within a lengthened case or band of mucus; and as these strings were in some parts much entangled together, I was at some pains to disentangle and measure them. I judged one of these strings to measure nearly, if not quite one hundred feet, and the other was but little less; and assuredly our wonder must be excited in contemplating so great a length, excluded from the body of so small an animal. This indeed can only be explained by the consideration that a great increase of size is caused by the absorption of fluid as the string of mucus is dragged from the parent; and that the expression dragged is not inappropriate is again rendered probable by the fact that in the first place no male was found in or near the pool, although in one of them that was killed the full amount of spawn had not been excluded. And again, a portion of the chain or string was twisted round a stalk of the dead plant, and it had even been passed through a narrow opening between two portions of the stalk, through which the parent must have with difficulty drawn itself; but through which it appeared impossible that the male when attached to the female could also have passed. I have found a few sprigs of furze that had accidentally fallen into a pool, which had been used for the same purpose of forming a fixed point, and by which the string might have been drawn from the body of the female. In one instance, where there were only two females of this species, the separate strings of spawn measured each about twenty feet; and on opening one of them which had been killed there were found about half a dozen black grains still remaining in the ovary, together with a large quantity of minute grains of a similar kind but pale white, as if they constituted a new formation of spawn.

The grains of ripe spawn, when first shed, appear of a deep black colour, but closer observation discovers within each of them a pale cicatricula; the size of the grain being nearly that of a radish seed. But before I proceed to describe the order of their development, I would remark that, on one

occasion, a large number of these creatures had formed themselves into a mass, as is sometimes the case with the common frog; and again a considerable number were collected in a small pool of fresh water high on the cliff, with spawn near them. This last was the only instance I know of the kind, but there was no pool in the rocks bordering the sea, within a great distance of the place to which they could have resorted. Among the particular actions which further characterize this species of toad, it is to be noticed that all the motions of a company appear to be carried on simultaneously; as if there existed an understood agreement between them, or that one pervading impulse was acting on the whole. Thus they are usually, if not invariably known to appear all together, and when they go away, it is in the same manner; and a curious instance of this occurred to a man of the coast-guard, who has often exerted himself in supplying me with examples of various sorts in Natural History; and who took three individuals of this species from a pool, out of a larger number that were in it, and placed them in a room in a bucket of water, that they might be at hand in the morning; but they made their escape in the night in a way that could not be explained; and, on going to the pool again, not one was to be found. This disappearance is the more remarkable, as no example of the Natterjack has been met with at any other than the breeding season through the extent of our coast. That the several stages of the progress of evolution in the ova might be better observed, some of these tadpoles were removed in a glass vessel to my dwelling; but, in the course of repeated visits to the pool, it was noticed that those which had been left to remain in their original situation had made greater progress towards maturity than such as had been removed, although even there I found much difference in the extent of development; so that it seemed probable that, even at the time of their being produced, some of the grains had been more advanced than others; or, perhaps, although the string was continuous, the length of time that had been required to bring the whole to light had been so considerable as to allow of a preponderating advance in the earliest over that which followed.

It might be thought tedious to enter minutely into all the changes which the grains of ova were observed to undergo in their progress to the condition of a perfect animal, but their general appearance is, to some extent, marked in the sketches which accompany this paper. I first noticed the size and appearance of the young which had just become separated from the chain or cord of mucus—an advance which was accomplished in the space of five days from my earliest

observation; but the next following changes went on rapidly, and voluntary motion had begun at the end of twelve days from the exclusion. The eye was well formed at an early stage; but, although the spawn was first seen near the end of March, the middle of July had passed when the legs made their appearance; and this they did with some difference, for in some instances the feet of the hindmost legs were first protruded, and in others those of the first pair were first seen. At this time some were in possession of four limbs, with scarcely the vestige of a tail; and this is the period when the colour changes from black to bronze, which last-mentioned appearance is a sign that the creature is about to leave the water for the land. As the tail becomes less the body diminishes in size, so that, when the tail has disappeared, the body has become less than half as large as when in the tadpole state; the greatest breadth being a little behind the eyes. At this time, that is, a few days after the middle of July, being desirous of knowing what effect the presence of sea-water would have on these little creatures, I removed from their native pool three specimens which had obtained their fore-legs, but still possessed a small remnant of tail, together with one which was furnished with only two legs and a tail at its full length. To the water in which they were placed there was added a fourth part of sea-water, with which mixture in a few minutes they were greatly affected, and after a quarter of an hour those with the legs appeared to be dead. One of them lay with its mouth wide open, and the legs of the others were stiffly stretched out, and they were thrust about unconsciously, sometimes on their backs with the motion of the water; while that one which still retained its tail appeared to be little affected, so that in its movements it thrust about its companions at pleasure. They remained in this condition for half an hour, after which this water was removed, and fresh water from a brook supplied to them; in which for another half hour the apparently dead tadpoles remained in the same condition; but, having set the vessel aside for two or three hours, when next examined they all were as lively as at first. It appears, therefore, that a mixture of sea-water is fatal to them at a later stage of growth, but that at first it does them little or no harm.

On the following morning the tadpole with the tail had acquired its fore-leg on the left side, and by the evening its companion leg had appeared; both of them perfect in form, but bent on themselves, and enclosed in a membranous sheath. The growth of these legs in stoutness is rapid, and presently after their appearance the body behind the aperture of the gills contracts in its dimensions. The margin of the fin on the border of the tail becomes waved before the hindmost legs

appear, and when these showed themselves, the feet were first freed, the limbs to which they were attached not being bent on themselves, as were the foremost. The first closing of the gill openings was not marked, but from observations made on frogs it is supposed to take place at the time when they quit the water for the land.

The skeleton of the Natterjack differs much from that of the common toad and frog.

MOONLIGHT AND COLOUR.

Whoever visited the Exhibition of the Royal Academy for the current year must have been struck by a remarkable painting representing a young woman of bony construction and Dutch-doll shape, standing in an old-fashioned bedroom in a flood of green light, which gave her a ghastly aspect and imparted a strange, half vital character to the heavy folds of a green dress that had fallen about her feet. No picture in the collection displayed so much force. If no name had been affixed to the description in tho catalogue, and the artist's previous works had been unknown, every critic must have pronounced him a man of genius and extraordinary skill, unhappily perverted by a kind of Yezidism, or worship of the ugly, which is fortunately rare. The name of the picture was the "Eve of St. Agnes," and the following quotation from Keats told what it was about:—

> "Full on this casement shone the wintry moon.
> * * * * *
> * * * Her vesper's done.
> Of all its wreathëd pearls her hair she frees;
> Unclasps her warmëd jewels one by one;
> Loosens her fragrant boddice; by degrees
> Her rich attire creeps rustling to her knees;
> Half hidden like a mermaid in seaweed,
> Pensive awhile she dreams awake, and sees,
> In fancy, fair Agnes in her bed;
> But dares not look behind, or all the charm is fled."

The reader of Keats will not accept the picture as an illustration of the exquisite fancy of the poet; the yodng female, with pinched waist and wooden figure, bears not the slightest resemblance to the "thoughtful Madeline,," "St. Agnes' Charmed Maid;" nor does the stream of bottle-green light, in which she and her drapery are involved, at all coincide with the description of "innumerable stains and splendid dyes," which the moonbeams in the story brought from the "diamonded panes of quaint device." Our purpose, however,

is neither to criticize the poem nor the picture; it is sufficient that we notice Mr. Millais' practical assertion, that the full moon shining through green glass, does involve the objects on which it falls in a bright and strong green light. Keats, speaking of the window in Madeline's chamber, tells us:—

> "Full on this casement shone the wintry moon,
> And threw warm gules on Madeline's fair breast,
> As down she knelt for Heaven's grace and boon;
> Rose bloom fell on her hands, together pressed;
> And on her silver cross soft amethyst,
> And on her hair a glory like a saint."

In these lines we have a poet's declaration that the rays of the moon can bring intense and glowing colour with them after traversing panes of stained glass. In the *Lay of the Last Minstrel*, another poet, famous for the general accuracy of his description, affirms the same thing when he says:—

> "The moonbeam kissed the holy pane,
> And threw on the pavement a bloody stain."

Some years ago the truth of this representation was questioned by the owner of a splendid manor-house in the north of England, when a large party was assembled, and the conversation turned upon the unusual splendour of a night in which the moon lit up the towers and battlements of the mansion, and threw a flood of radiance down the forest-like glades of the extensive park. A fine Gothic hall, partly lit by stained glass windows, afforded ready means of testing this interesting question, but the experiment did not enable the precise conditions imagined by the poet to be imitated, as white glass was present in much larger quantity than the coloured panes. On entering the hall, into which the moonlight came freely through several large windows, not a ray of coloured light could be seen upon the furniture or the oak floor, although the tracery of the windows was distinctly marked out by the shadow, and the spaces occupied by the coloured panes were indicated by diminution of light. A white cloth was brought and spread upon one of the tables in the full moonshine, but still no noticeable evidence of colour could be obtained, and thus great doubt was thrown upon the possibility of such effects being produced as those mentioned by Scott in Deloraine's visit to the "Monk of St. Mary's Isle," or such as Keats imagined when his Madeline sought for "visions of delight" according to the formula prescribed to lovers upon St. Agnes' Eve.

The purpose of this paper is not to offer a complete explanation of a matter that has not been duly investigated, and which presents many complicated considerations, but rather to

suggest to the readers of the INTELLECTUAL OBSERVER a series of pleasing and instructive experiments, which may occupy some happy hours during the glorious nights of the autumn and winter moon. Moonlight differs chiefly from sunlight in the matter of intensity, and also, to a variable and not easily definable extent, in the matter of colour. Sir John Herschel observes that if a ball of quicklime ignited in the oxy-hydrogen flame, and producing the most intense artificial light, be held between the eye and the sun, and both viewed through a dark glass, the lime ball appears like a black spot on the face of our great luminary, so great is the difference between the intensity of the two lights. He adds that it would require 146 balls of quicklime, each the size of the sun, to equal his illuminating power. As a result of this intensity of solar light and of the refractive power of the air, the colour, as well as the form, of objects can be seen in ordinary day-time out of the direct line of the sun's beams. When a coloured object is placed in full sunlight it becomes brighter, but does not look changed unless its surface is highly reflective and seen at a certain angle, and then it may seem *white*, as the black wings of rooks occasionally do when they occupy a particular position with reference to the sun and the eye of the observer.

On a sunshiny morning take two books or pieces of paper, one bright blue and the other bright red, out in the open air, and place them in the sun's beams. Both look very brilliant, and the contrast between them is very striking. Next place them close together so as to make a continuous surface, and the discrepancy of colour becomes more striking. Then take a narrow stick, and hold it an inch or two above the books, so that one half its shadow falls on the red one and the other half on the blue. The shadow will be sufficiently transparent to enable the blue and red to be discerned through it, but for want of light the colours will be so enfeebled that nothing that can be called a contrast will be observed in the two portions of the shadow line.

In the next experiment place three books, bright blue, red, and green, on the ground in full sunlight, stand upright and hold a long ruler so as to throw its shadow across the three. In this case the shadow will be much lighter than in the preceding, as more diffused light is able to get at the parts excluded from the direct rays. Upon the red book the shadow will appear of a purplish black hue, though not deep; upon the blue book it will look bluer from the transmission of blue light through it; and upon the green book it will look greener from the same cause. A yellow book, under such circumstances, behaves similar to a red one. Thus, diminishing the light by a shadow has affected the bright red book more than the bright

green or the bright blue one, so far as change in the colour of the partially lit portion is concerned.

Another experiment may be made by taking three books, bright red, blue, and green, into a dark cupboard, and letting in little light by slow degrees. The red will be seen first, the green next, and the blue last. Yellow would have been visible before the red.

As no object possesses an inherent property called *colour*, but simply a power of acting in a definite manner upon light, absorbing or reflecting more or less of the seven prismatic colours, or so-called components of white light, it follows that what we call yellow, red, or blue objects cannot be seen as such, unless enough of the right kind of light falls upon them, and the whitest body looks dark in proportion as white light is prevented from reaching it, and, when only just enough white light is admitted to render a sheet of white paper visible, it has a dark grey aspect, such as would be obtained by grinding up enough charcoal with a bit of chalk to nearly destroy the whiteness of the latter.

These facts are necessary as a preliminary towards understanding the effects of moonlight. The amazing luminosity of the sun has been already spoken of, and Woollaston estimated it as being 801,072 times brighter than the full moon;* but taking it at half this, the difference will be immense. When, therefore, moonlight is substituted for sunlight, an enormous change must be made in the intensity of all colours, and to such an extent does this take place that many objects look dark, or resemble shadows, in moonlight; whereas in sunlight they may appear bright and of a strongly expressed tint. When light is reflected from the surface of a coloured object, more or less luminosity is lost, according to the kind of colour and the nature of the surface. If the intensity of the light is sufficiently diminished, the colour may vanish and be replaced by a nondescript hue, while the form remains visible. Now, ordinary moonlight is not intense enough, even to indicate what many coloured objects would look like in sunlight, although bright primary or bright secondary colours can be approximately made out. Light loses intensity when it passes through transparent bodies, such as coloured glass; and a piece of blue or red glass, which distinctly gives its own tincture to solar rays, will, under some circumstances, appear not to tinge the feebler rays of the moon.

If a sheet of white paper is held so that it receives sunlight that has passed through coloured glass, a strong tint is

* Michelo and Euler estimated it on theoretical grounds at 450,000 and 374,000, and Bouguer by measurement of shadows of the light of wax tapers at only 300,000. See *Cosmos* (Bohn), vol. iii., p. 127.

thrown upon its surface, and if the experiment is made by holding a small piece of coloured glass in the hand, leaving white light to fall upon adjacent portions of the paper, the contrast between the two parts is very distinct. Do the same thing in diffused moonlight, and so little colour is obtained that the chief contrast is that of light and shadow, not of white light and colour, and great surprise is usually felt the first time the operation is performed.

Unless the piece of coloured glass in the last experiment is held very near the paper, its power of imparting colour to the moonlight is scarcely noticeable, and for anything *approaching* to the effect described by Keats and Scott, or depicted by Millais, a much brighter moonlight would be required than ordinary mortals ever had the chance to see; unless all diffused white light were excluded, so that a general darkness contrasted with limited patches of coloured light.

When the solar spectrum is viewed by means of a prism, the eye instantly detects a great diversity in brightness as well as in colour; the yellow and green portions being very brilliant; and the purple deepening into shade. With a spectroscope admitting the light by means of a slit that can be opened or shut at pleasure, it is easy to let in so little light as only just to make the most luminous part of the spectrum visible, while the rest remains unseen. The feeble intensity of moonlight as compared with sunlight will be most felt with regard to the violet rays and next with regard to the indigo rays. These may be lessened in intensity, so as to make their action unnoticeable under certain conditions, while the red, orange, yellow, and green light may be sufficient to give considerable power to objects of the same or similar colours.

Poets speak of the "pale moon," the "wan moon," the "silver light of the moon," and so forth; but optically moonlight is generally called yellow. When the moon is seen in broad daylight, it looks like a whiteish cloud upon the sky, and without a decided yellow tint. As evening approaches, and the moon competes in brilliance with the strong but declining twilight of summer, she looks yellower, though pale, and a telescope with a low eye-piece, which enables more of her light to reach the eye, makes the yellowness more decided, and a little fog deepens it to a copper red. As twilight fades, and solar light is thus removed from competition and contrast, the moon looks whiter or bluer in fine weather, and many artists make prominent use of blueish grey tints to paint their moonlight scenes. Coleridge speaks of the "yellow moon-lit sea" in one of his poems; but he probably alluded to a local colour, and did not impute to our satellite the power of throwing a yellow tinge over sea of any kind.

Having made the preceding experiments in the manner suggested, it will be interesting to notice how much the effect of tinted moonlight may be increased by operating in a dark room, with only one opening for the lunar rays. Under such circumstances, if the moon be nearly full, and a piece of bright red glass held opposite an opening of moderate dimensions, a distinct dark red tint may be thrown on white paper, or linen, but no noticeable colour can be communicated to dark objects unless their surface is highly reflective. A looking-glass shows the colour well, and, still better, the convex surface of a white china cup, which has a good glaze. A striking effect may also be produced by receiving the tinted light on a round white glass bottle full of water, which in a red light becomes "warm gules." Green glass succeeds very well, so does blue, but the colour is less powerful. The strongest effect is obtained by holding a good reflecting surface near the glass, but a noticeable tint may be thrown across the room on a white ground.

Having obtained distinct coloration in this way, introduce a lamp, turned down so as to yield scarcely any light, and then gradually turn it up until the colours give place wholly or partially to the homogeneous, yellowish-white light which the lamp diffuses. By this means we get a notion of the strength or weakness of lunar tints, but we have to consider their effects from another point of view.

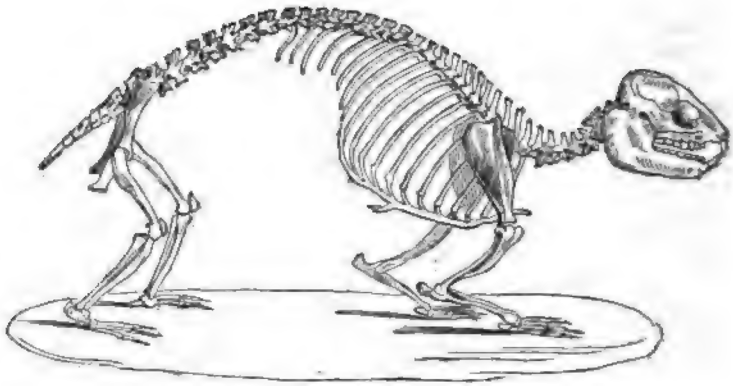
In daylight we see coloured objects for the most part in contrast or harmony with other colours, and the effect of each is thus modified to a considerable extent. Thus a grey pattern on a yellow ground looks violet, that being the accidental or complementary colour of yellow. A blue ground, in like manner, makes a grey pattern thrown on it appear tinged with orange, which is the complementary of blue. All eyes that are not very defective are sufficiently affected by complementary colours to modify very materially the impression produced by surrounding objects, but the sensitiveness of eyes to colour-action of this or any other kind depends partly upon their constitution, and very much upon the amount of intelligent exercise their owners have given them. Most persons are content to go through life half blind, because they are too lazy or too stupid to make a rational use of the organs bestowed upon them. But even good and practised eyes differ much in sensitiveness to particular colours and in ability to be affected by accidental colours. Most people can see the accidental colour of a blue or red wafer held for a few moments in strong sunlight, but have to look very steadily and for some time in order to see it developed in a somewhat shady room. Moonlight is too feeble to affect our visual organs much through accidental colours,

and thus objects seen in moonlight and in sunlight will differ on this account, as well as by simple reason of diminished intensity of illumination.

Let us now turn to another set of experiments, and, when the moon is at or near her full, in clear weather, let one or more members of a family dress themselves in strongly-coloured clothes, red feathers, green shawls, blue silk dresses, etc., and then walk in a moon-lit garden, leaving others to guess what they have put on. Generally speaking very considerable mistakes will be made, although, when close to bright red, blue, green, or yellow objects, their colours will be approximately guessed. In one set of trials which we made, scarlet was pronounced crimson, but at the same time the supposed black cloth binding of a book was called purple, which was found correct; thus showing that the blue and violet rays could not be very deficient in force. Tertiary colours will be more bewildering than primaries or secondaries, and different eyes will pronounce different judgments, the discrepancy between a set of observers in moonlight not necessarily being the same as might exist between them in daylight.

The colour of shadows in moonlight will require long study, and so will the tints or hues of trees in full leaf, near and distant, both in the direct rays and out of them; and it must be remembered that all moonlight effects will vary according to the state of the air and the brightness of the luminary.

The coloured cards furnished with the "Colour-Top" will help these inquiries, if they happen to be at hand; otherwise, books in various cloth bindings, and articles of clothing and ornament will readily supply what is required. Besides these a few strips of coloured glass, easily obtained from a glazier, will be wanted; but, when once attention has been called to the subject, an agreeable inquiry may be conducted with very little trouble and no expense.



THE HYRAX OF SYRIA.

BY THE REV. C. H. MIDDLETON, B.A.

Most persons who are at all acquainted with natural history, are well aware that the classification of animals is not always a simple matter, that "any attempt to divide living beings by distinct lines of demarcation, as we mark out the minor divisions of a great kingdom on a map, are hopeless, unless we submit to endless exceptions, to frequent inconveniences, and occasional absurdities." There are creatures which in external appearance, in habits, or it may be in osteological or visceral formation, seem to belong rather to one class while they are actually members of another. The student of comparative anatomy feels no surprise at this—his surprise is to find the gradations from one typical form to another so incomplete. Between nearly all groups there are found intermediate forms, connecting links of greater or less importance; thus the *Colugo*, or flying lemur, to some extent connects the monkey and the bat; the Aard wolf (*Proteles cristatus*) comes between the hyena and the civet. The hyrax appears to present one of these intermediate or transition forms; for a long time it was regarded as a Rodent, and certainly a plantigrade creature, about the size of an ordinary wild rabbit, with thick, soft brown fur, and incisor-like teeth, with large brilliant eyes set forward in the head, and a moustachioed muzzle, living among rocks and in holes in banks, had some claim to be classed among hares and rabbits; and taking it to be, as it undoubtedly is, the Shâphân, or "coney" of Scripture, identified with the coney by the Rabbinical writers, classed with the hare in the sacred books,

Leviticus xi. 5; Deut. xiv. 7, there seems an apparent prescription in its favour.*

An examination of the skeleton and the intestinal canal shows that it is not a Rodent at all, but that it is a Pachyderm, allied to the horse and the hippopotamus, coming, among now existing animals, between the rhinoceros and the tapir—creatures as unlike it to all outward appearance as can well be conceived. H. N. Turner, in his proposed arrangement of the Perissodactyla, classes in order—Rhinoceros, Acerotherium (fossil), Elasmotherium (fossil), Hyrax, Palæotherium (fossil), Paloptotherium (fossil), Tapirus, etc. Professor Huxley, see *Medical Times*, of May 23rd, speaking of the classification of mammalia, tells us that though Cuvier endeavoured to prove hyrax a *true* Pachyderm, yet Milne-Edwards, from an investigation of certain peculiarities of its internal economy, considers that it has affinity with both Pachyderms and Rodents.

Naturalists speak of several species of hyrax, but I cannot make out more than five, if indeed *variety* is not rather the word to use of two of them. Perhaps the best known is the *Hyrax Capensis*, the rock-rabbit of South Africa; its habits are very similar to those of the *H. Syriacus*; each lives among the rocks, and is fond of basking in the sun, "feeding with apparent carelessness on the aromatic herbage of the mountain side; it is, however, tolerably secure, in spite of its apparent negligence, for a sentinel is always on guard ready to warn his companions by a peculiar shrill cry of the approach of danger." A second species is *H. arboreus*, described by Colonel Hamilton Smith; "it lives," he says, "in the hollows of decayed trees, which it climbs easily;" beyond this little is known. A third is *Hyrax Habessinicus*, which is found in great numbers in the Somàli country, in Eastern Africa, latitude 9° north, longitude 47° east, reported upon by Captain J. H. Speke; I can learn no particulars of this. Again, there is *H. dorsalis*, described by Mr. Louis Frazer, Her Majesty's Consul at Whidah, as frequenting the island of Fernando Po, in the Bight of Biafra, of which Mr. Waterhouse writes, that he believes it to be entirely distinct from both *H. Capensis* and *Syriacus*, and is inclined to class it apart from *arboreus*. It is nocturnal in its habits, sleeps in trees all day, and feeds on leaves, etc., at night; though difficult to find, it is no doubt common, since its loud and peculiar cry is nightly heard during the rainy season; its native name is Naybar. *Shaw* in *General Zoology*, vol. ii. part 1, refers to a Hudson's

* Curiously enough, in the Septuagint, where the coney and the hare are *both* referred to, we find *τον δασυποδα—και τον χοιρογρυλλιον*, where, in Psalm civ. 18 (Psalm ciii. of LXX.), the English translation has "conies," the word used is *χοιρογρυλλιοις* (in textu Grabii *λαγωοις*). In Proverbs xxx. 26, for "conies" again we find *οι χοιρογρυλλιοι*.

Bay hyrax, which "has two upper and four lower front rodent-like teeth; its feet are tetradactylous, like those of the Cape hyrax, and it has rounded claws on all the toes." I think this hyrax was known to no one else. The Abyssinian hyrax described by Bruce, and that found in Syria and Arabia, are probably identical, *H. Syriacus.* In the latter countries, he tells us it "is called Israel's sheep, or Gaunim Israel, from its frequenting the rocks of Horeb and Sinai, where the children of Israel made their forty years' peregrination."

There is a singular error in Griffith's *Cuvier*, vol. v. He says that the *H. Syriacus* differs from the South African species principally "in having only three toes on the anterior feet," and (which is correct) "long bristles or hairs dispersed over the upper part of the body." Again, in his description of the genus Hyrax, he gives "toes before, four or three; behind four," and, where he is as certainly wrong, "eyes small."

The specimen from which the accompanying drawing of the skeleton is taken was sent from Mar Saba, a deep rocky ravine in the wilderness of Judæa; it is that of a young adult male. The skin has been sacrificed that the skeleton might be perfect. The spinal column, it will be seen, is very close set; it contains seven cervical, twenty dorsal, eight lumbar vertebræ, add to these five sacral and six coccygeal. In the Cape hyrax Mr. Martin found seven cervical, twenty dorsal, and nine lumbar. Professor Owen also, when writing of the same species, gives twenty-nine as the dorso-lumbar vertebræ. Mr. Martin counts in *Capensis* the sacral and coccygeal as fourteen. In the *H. Syriacus* I can only make eleven. He gives for *H. Capensis* seven true and fourteen false ribs. In *H. Syriacus* there are seven true and thirteen false. These differences are curious in animals so nearly allied as the two species must be. The number of ribs on a side, twenty, is only exceeded in one mammal, the *Bradypus didactylus*, or two-toed sloth, which has twenty-two; no other quadruped approaches it; while its congeners the rhinoceros and tapir, have respectively sixteen and eighteen.*

The most marked peculiarity of the skull is the size and strength of the lower jaw, which is unusually massive, nothing we know of in the economy of the animal seeming to require a jaw so powerful; there is, in proportion, a greater depth and strength

* Professor Owen in his paper on the "Anatomy of the Auroch" writes:—"The constancy in the number of the true vertebræ in the *Artiodactyle Ungulates* is the more remarkable and demonstrative of their natural co-affinity, by contrast with the variable number of those vertebræ in the odd-toed, or *Perisodactyle* group, in which we find twenty-two dorso-lumbar vertebræ in the rhinoceros, twenty-three in the tapir or palæotherium, and as many as twenty-nine in the little hyrax."

of the horizontal ramus, and a greater convexity of the ascending ramus than in other known quadrupeds. In hyrax, as in the armadilloes, the muscular system has this great peculiarity, that the digastric muscle of the lower jaw arises from the upper part of the sternum instead of from the occiput or temporal bone, and it is inserted into the whole ramus or angle of the lower jaw. It is of remarkable size and strength, and it is this muscle which occasions the peculiar fulness of the neck in hyrax. The general conformation of the skull is wide shaped and compact, and somewhat abrupt anteriorly; the eye sockets are large, and placed forward; the auditory meatus is small, a well-developed post-tympanic process seems to take the place of the mastoid. The dentition presents a marked resemblance to that of the rhinoceros. The molars are fourteen in each jaw, the larger ones being placed farthest back, the anterior ones are said to fall out soon after the animal has attained its full growth; they have not been shed in the skeleton before me.

In Cuvier I read that two canines are found in the upper jaw of the young animal, but there are no traces of any here. The incisors are two above, placed apart, and four below, the outer pair being much larger than the inner ones.

The fore feet, as in the elephant, have each four digits; they are the second, third, fourth, and fifth. (In this specimen is seen a rudimentary first digit, which, however, is probably abnormal.) Each digit is buried in the skin as far as the little hoof or nail, which, however, only covers the upper, not the lower surface. The whole foot is placed to the ground, and has a callous sole. (All other Pachydermata are, I believe, digitigrade.) The hind foot, which bears a striking resemblance to that of the rhinoceros, has only three digits, the second, third, and fourth; the third and fourth having nails like the fore feet, the second being armed with a claw, curved and pointed; the fore part of the astragalus is divided into two very unequal facets; the os magnum and the digitus medius which it supports are large. The stomach is certainly not that of a ruminant, though it to some extent approaches that type. It has strong muscular fibres about the middle, which partially constrict it, and serve in some degree to divide it into two pouches; the organ is at this part folded upon itself, but there is no valve between these pouches and no intermediate receptacle for undigested food. Mr. R. Reed says of the Cape hyrax that the specimens he shot had their stomachs much distended with scarcely masticated food, and further says of one he had in confinement that he had heard it chewing its food by night, he believes ruminating when everything around was quiet. The small intestine, which is not much thicker than a goose-quill, has about twelve glandular pouches from

three to five inches apart, about three lines in depth, with their orifices placed towards the cœcum. Their use is not very clear.

The cœcum has a great analogy to that of the hare, and other Rodents, being sacculated and distended with a black pultaceous matter; in form one would compare it with that of the tapir, its magnitude arising more from its breadth than its length. The whole length of the intestinal canal is about six times the length of the animal Owen adds, in looking at the vertebrata for an analogous form of intestinal canal, hyrax stands nearly alone. Among mammalia it is only in a few of the Edentata that the double cœcum is met with, as in myrmecophaga, didactyla, and dasypus 6-cinctus; while in birds, although the double cœcum more generally prevails, yet an additional single cœcum anterior to these has only been found in a few species. In the bird, however, the single anterior cœcum exhibits merely a trace of structure peculiar to embryonic life, in hyrax it evidently performs an important part of digestion. He considers that the double cœcum of hyrax indicates an affinity to the group which intervenes in the system of Cuvier between the order in which it was originally placed and the one to which Cuvier transferred it. It is interesting to note that while the facies of hyrax so far simulates that of a rodent as to have deceived the older naturalists, yet nature, as if in abhorrence to the saltus, has left in the internal structure an impression borrowed from the type of the Edentata.

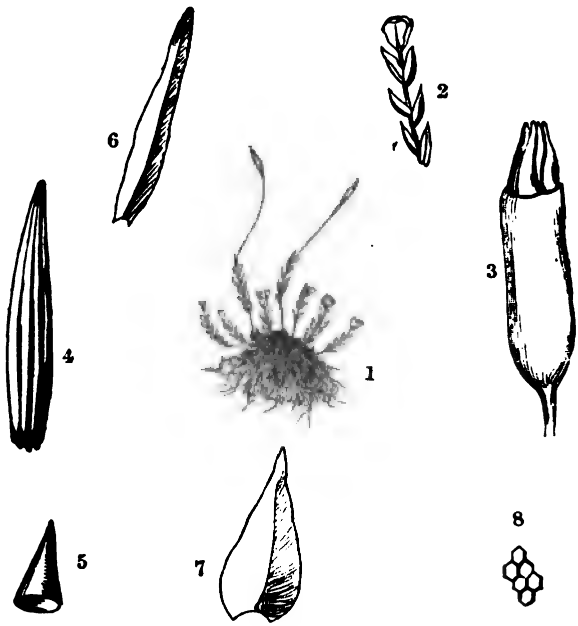
The question whether hyrax ruminates is not easy to answer. I have the authority of Professor Huxley for asserting that the non-possession of a ruminant stomach is no proof that the action is impossible, and cases are recorded on the part of the hare, the kangaroo, and even of man himself, though in each of these it has certainly been an abnormal act. The stomach of the hyrax, partially constricted by a sphincter muscle, and having no cardiac valve, renders it perfectly possible that it is a habit of the animal generally, as it certainly seems to have been of the one kept by Mr. Reed, referred to above.

The soft, deep fur of the hyrax is unique among the Pachyderms, and more closely resembles that of the Rodents in appearance; its microscopic character is however totally unlike theirs. The close hair of the peccary is bristly, more like the long, black, erinaceous hairs which are scattered over the coat of the hyrax. Bruce imagined that it was from these hairs that the animal derived its Abyssinian name of Ashkoko, from ashkok, a thorn. These hairs are absent in *Capensis*. The fur, which is of a greyish-brown, does not, as before stated, extend to the under surface of the feet. The ears are small, rounded, and white within; the snout, which in every other species of

this genus is more or less prolonged, is in hyrax short, and is furnished with labial whiskers like many of the Rodentia.

The habits of the animal much resemble those of the rabbit; it is very timid, and alive to the approach of danger. If this is, as is believed, the coney of Scripture, its description there is especially fitting. They are a "feeble folk," who "make their houses in the rocks," which are thus a "refuge for the conies." Though they can bite sharply when handled, they are in no way fitted for self-defence, and have a lively instinct of self-preservation, and are "exceeding wise" in availing themselves of shelter. They are gregarious, and, as I learn from a friend who has visited their haunts in the neighbourhood of the Dead Sea, they seldom leave the wild rocks among which they hide in the broad daylight, but for a short time about sunrise, and from an hour before sunset until dark. He has seen them, though never able to approach very near, coming out in parties to feed, and frolicking about in the nimblest fashion their heavy bodies and short legs allow, feeding on the young shoots chiefly of the *Scilla maritima* which abounds there, while one of their number is always posted on some ledge of rock to keep a look-out and warn them of danger; he does this by a plaintive warning cry, when they all immediately scuttle away to their holes—the slightest movement or shadow of the enemy is sufficient. They principally depend on the power of their sight, not on their hearing, which, from the form and the small aperture of their ears, is far less perfect than their sight; in fact, he has spoken to an attendant when on the cliffs immediately over head without disturbing them. Bruce, probably in ignorance of the nature of their food, tells how he shut up a tame one, fasting, with fowls and smaller birds, but "he never showed any alteration of behaviour in their presence, but treated them with a kind of absolute indifference." They are very cleanly, and are said to be good eating, but of this last we have no evidence.

Note.—I have spoken of the hyrax as the coney of Scripture. Kitto says that it was first on the authority of the Rabbinical writers that the shâphân has been identified with the coney. There is no native rabbit in Syria; the only other animal which could be considered the shâphân was the jerboa, and this was held by Burckhardt; but the habits of the jerboa do not correspond with the Scriptural descriptions.—See *Smith's Dictionary of the Bible*, under the head of "CONEY."



TETRAPHIS PELLUCIDA, PELLUCID FOUR-TOOTHED MOSS.*

BY M. G. CAMPBELL.

MOSSES have a species of arithmetical progression which, as far as we are aware, is peculiar to themselves; and on examining with the microscope the orifice of the little urn containing the spores or seed, we shall find that some genera, as *Sphagnum* (Bog Moss), *Gymnostomum*, *Anœctangium*, and *Stylostegium* (Beardless Mosses), etc., are destitute of the little circle of fringe which we call peristome, or teeth. Next in arithmetical order will come *Tetraphis* and *Tetradontium*, each possessing four teeth; then the lesser Yoke Moss, and Mr. Forster's Yoke Moss with eight teeth; then many genera with a peristome of sixteen teeth, others with thirty-two teeth, and others again with sixty-four. But we shall search in vain for any intervening numbers.

The *Tetraphis pellucida*, fruiting in this month, has been selected for our present consideration. Its generic name is

* *Explanation of the Cut.*—Fig. 1. *Tetraphis pellucida*, nat. size. Fig. 2. Stem, showing crown of broadly ob-cordate leaves surrounding the gemmæ of the immature plant. Fig. 3. Capsule, mag. Fig. 4. Calyptra, mag. Fig. 5. Lid, mag. Fig. 6 and 7. Lower and upper leaves of the stem, mag. Fig. 8. Areolæ, or net-work of the leaf, highly magnified.

derived from *τετρα*, for *τετορα*, four; and a derivative of *φυω*, meaning a process or production, in allusion to its four prominences or teeth. It is a perennial, and grows in dense patches on the decaying roots of trees in shady and rocky places, as also on banks in a peaty soil.

Having terminal fruit it belongs to the *Acrocarpous* section of mosses; and in the *Calyptra*, which is mitriform, irregularly plicate, and lacerated at the base, it has considerable resemblance to the *Orthotrichums*, which we considered in our July number; it also resembles them in the internal structure of the fruit, that portion of the columella which is included within the peristome, separating from the cellular tissue that fills up the interior of the lid above the peristome; a structure, it may be remembered, observable in *Polytrichum*.*

The stems of *Tetraphis pellucida* are slender, erect, simple, or dichotomous, *i. e.*, forked with the branches in pairs; when old crowded together, growing from a common base to the height of from half an inch to an inch, bearing small scattered leaves in the lower parts, but crowned with a tuft of larger, longer, and more crowded leaves at the summit, or with a cup-shaped cluster of very broad leaves, surrounding a group of pedicellate lentiforme† gemmæ‡. These leaves, except at the summit of the fertile stem, are mostly three ranked, ovate-lanceolate, sub-erect, the upper ones larger and more spreading, variously curved, and entire in the margin; and under the microscope, they present a beautiful piece of hexagonal reticulation, from the shape of the *areolæ*, or spaces between the cellules of the leaf. The nerve ceases below the apex.

The inflorescence is monoicous, the flowers are gemmiform or bud-like, and the barren flower issues from a branch growing out of an abortive fertile flower. The antheridia, which are analogous to the anthers of flowering plants, are mixed with filiform *paraphyses*, or succulent jointed, hair-like bodies, and the archegonia, which answer to the pistils of flowering plants, are few.

The capsule is of a yellowish brown colour, sub-cylindrical, regular or slightly bent, with a red tumid border at the mouth, and seated on a reddish fruit-stalk about half an inch or more in length. The peristome is inserted below the orifice of the capsule, and permanently united to the included portion of the columella, which, with it, is divided into four pyramidal teeth, each being marked with longitudinal striæ. The calyptra is whitish, but brown at the apex; and the capsules usually solitary, though sometimes two are found together. The plant is of a light green above, reddish below, and at the base, con-

* Vide No. 16 of the Intellectual Observer.

† Lentiforme, shaped like a vetch seed.

‡ Loose granular bodies capable of becoming plants.

nected by closely interwoven and matted radicles, in colour approaching to a cinnamon brown.

We give an illustration of the natural size of this moss, and also of its various parts magnified. It fruits throughout August and September.

MARCET ON NOCTURNAL RADIATION.

Professor Marcet communicated to the *Société de Physique et d'Histoire Naturel* the following paper on "The Effects of Nocturnal Radiation in Tropical Regions." We translate it from the *Archives des Sciences* :—

"I. profited," says the professor, "by the prolonged sojourn of one of my sons in Australia, to engage him in certain observations on the effects of nocturnal radiation in a climate so different from our own. With this end in view, I supplied him with the necessary directions, and with thermometers on whose accuracy I could rely.

"Observations made during several years back at Geneva and Montpellier leave no doubt that in temperate climates, at the moment of sunset, provided the sky be clear, the temperature of the air in immediate contact with the soil is notably lower than the temperature of the same air at an elevation of a few feet. Although, so far as I am aware, observations had not been made in the region of the torrid zone, it appeared natural to conclude, *à priori*, that they would exhibit the same phenomena, with perhaps greater intensity, on account of the great transparency of the air, which is favourable to radiation; and because in those countries the surface of the earth is more strongly heated during the day, and might be expected to radiate with corresponding vigour during the night. I learnt, not without surprise, that this was not the case. It appeared, in fact, to result from a series of observations made by my son at his station on Logan Downs, in Queensland, 22° south latitude, and thirty or forty leagues distant from the sea, that the phenomenon of increase of temperature, in proportion to elevation above the soil, was not observed either at sunrise or sunset, or if it exists at all it is to an extent scarcely perceptible. He found, for example, by a series of observations made in March and April, 1862, under circumstances that were apparently very favourable to nocturnal radiation, that the difference between a thermometer placed at three centimeters above the ground, and another at a meter and a half above it, did not usually exceed from 0°,1 to 0°,2 Cent., three times it was from 0 to 3, and once from 0 to 4.

"This result, completely unexpected by me, could not be

attributed to an absence of nocturnal radiation from the soil, for this radiation, which depends on the heat acquired by the earth during the day, should evidently be more intense, other things being equal, in torrid than in temperate regions. We must, therefore, as it appears to me, seek for the explanation in the two following circumstances:—First. In tropical regions the heat of the sun is so intense that his rays warm not only the surface of the earth, but penetrate the soil to a certain depth. It follows from this that at sunset, when the surface of the earth begins to cool by radiation, the diurnal heat concentrated in the interior arrives at this surface, warms it again, and prevents the refrigeration of the stratum of air in immediate contact with it. The second circumstance which, according to my opinion, may explain the absence in certain tropical regions of the effects produced in temperate climates by nocturnal radiation, depends on the great quantity of water which the atmosphere holds in the form of elastic vapour, in a country whose mean temperature is elevated, as Queensland. The recent researches of Professor Tyndale have shown to what extent the elastic vapour of water operates to intercept the obscure heat emitted by the soil. This physicist has calculated that even in England, where the air must contain infinitely less vapour than in the torrid zone, it nevertheless suffices to intercept, at a distance of less than ten feet from the surface, the tenth part of the heat emitted by the soil. In tropical countries, and especially in those which are not far removed from the sea, the quantity of aqueous vapour contained in the atmosphere is no doubt more considerable, and the quantity of intercepted heat should be proportionately greater, and in consequence the effects produced by the nocturnal radiation of the soil less noticeable.

"I have the more confidence in my son's observations as M. Lucien de la Rive has arrived at analogous results on the plains of Egypt in the neighbourhood of the Nile. M. de la Rive did not, it is true, attach to his observations the importance they probably deserve, partly because they were not very numerous, and partly because during the season at which they were made a decided wind frequently arose at sunset, and mingled the strata of the air so as to modify to a certain extent the phenomenon of temperature resulting from external radiation. I confess, however, that the analogy between his results and those obtained by my son in a country still nearer the equator, leads me to think, in the absence of more ample information, that the phenomenon of nocturnal radiation, and the effects which it produces, exhibit themselves in climates of the torrid region in a very different manner from that in which they are displayed in the temperate zone.

"It may, perhaps, be alleged as an objection to this view, that travellers who have crossed the great sandy deserts of the interior of Africa, for the most part describe the contrast between the almost insupportable heat of the day, and the refrigeration of the atmosphere that takes place after the setting of the sun, and which can only be due to the intensity of radiation at this period of the evening. It might, I think, be replied to this objection by remarking that in these immense deserts, most often situated at a great distance from the sea, the nearly total absence of water causes the atmosphere to retain a condition of nearly absolute dryness. We admit that the quantity of water which the atmosphere can retain, in the state of elastic vapour, depends upon its temperature; but it is, nevertheless, necessary that the water should exist, and when there is none, the atmosphere, however high its temperature, is necessarily deprived of that aqueous vapour which is able to intercept the terrestrial radiation with so much power. Besides, there can be no reason why nocturnal radiation should not reach its maximum effect under circumstances which are otherwise entirely favourable to its development, and produce a striking contrast of temperature as soon as the sun has disappeared from the horizon."

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

CHEMICAL SOCIETY.—*June* 18*th*.

A Curious Case of Electrolytic Action.—Among the papers read at the last meeting of the Chemical Society before the vacation was a short note by Mr. Abel, chemist to the War Department, on a singular appearance occasionally shown by Armstrong shot which have been stored some time. It must be premised that there are two modes of completing these shot: in one the iron shot has grooves upon its surface, which help to keep the lead covering which is cast over the iron body in its place; in the other mode the iron shot is first "galvanized," *i. e.*, dipped into a bath of melted zinc, and then into a second bath containing either an alloy of lead and tin, or lead with a small proportion of antimony. Shot finished as last described, exhibit the peculiar appearance examined by Mr. Abel. One or more blisters are formed, often of considerable size, sometimes one or two inches in diameter, and a quarter of an inch in height. On being opened under water it is found that these blisters contain pure hydrogen gas, existing under a pressure of ten atmospheres. This hydrogen evidently owes its origin to the

decomposition of a small portion of water which has adhered to the chloride of ammonium (sal ammoniac) and chloride of zinc, employed to cover the bath of melted zinc used to "galvanize" the iron. An electrolytic action subsequently takes place, during which the film of water is decomposed, the oxygen uniting with the zinc, and the hydrogen being liberated in the gaseous form. In tracing its probable origin, Mr. Abel discovered that chloride of zinc, when once combined with water, could not be again rendered perfectly anhydrous by exposure to a degree of heat somewhat above the melting point of zinc; for on throwing fragments of zinc into the fused chloride they were quickly melted, giving rise to the production of hydrogen gas, and the formation of an oxychloride of the metal. It was not difficult to suppose a similar change occurring in the lapse of time at the ordinary temperature; chloride of zinc would undoubtedly be formed by the action of the sal-ammoniac flux upon zinc or its oxide, and this might readily attach itself to slight asperities upon the surface of the shot, become hydrated, and ultimately enclosed within the lead coating. The torn, fibrous aspect of the metal on the inner surfaces of the blister, and the detection of chlorine in the cavities, confirmed these opinions, and pointed directly to the origin of these remarkable appearances upon the Armstrong shot.

ENTOMOLOGICAL SOCIETY.—*July 6th.*

HERMAPHRODITE FORM OF PAPILIO.—Professor Westwood exhibited specimens of two species of butterfly, *Papilio Castor* and *Papilio Pollux*, which by some naturalists have been regarded as the two sexes of one and the same species. Professor Westwood, however, possessed males of both forms, and the female of *P. Pollux*. One specimen of *Papilio Castor* was remarkable as showing the forms of both sexes, or rather as having a gynandromorphous wing, part of which, both on the upper and under sides, exhibited the colorations and marking of the male, and part on both sides having the colours and markings of the female. It was remarkable, however, that neither the male nor the female markings correspond on both sides of the wing. From these peculiar circumstances, Professor Westwood maintained that the *Papilio Castor* and *Papilio Pollux* were not the two sexes of one species, but in reality two perfectly distinct species.

GEOLOGICAL SOCIETY.

ON THE OCCURRENCE OF ALBERTITE AT MOUNTGERALD, SCOTLAND. By A. C. Mackenzie, Esq. Communicated by Professor J. Tennant, F.G.S.—In making a drain on a farm near Mountgerald, a fissure was discovered which contained a bituminous substance very similar to the Albertite of New Brunswick; a deposit of a similar nature was also discovered in making a cutting through "The Craig," near Mountgerald. The author described the stratigraphical and lithological characters of the rocks met with in making this cutting, and stated that as many as thirty-six veins containing this mineral

were passed through. The characters of this singular mineral were fully described in the second volume of the INTELLECTUAL OBSERVER, page 145, and the peculiar qualities of the hydro-carbon oil obtained by its destructive distillation were alluded to. Since that period, this oil has undergone further examination at the hands of Mr. A. H. Church, Professor of Chemistry in the Agricultural College, Cirencester. He finds that, submitted to careful fractional distillation, this oil, though fluid, and nearly colourless, exhibits several remarkable peculiarities, for it does not commence to boil till the thermometer has risen to 338° Fahrenheit, while no less than one-third of the whole material remains in the retort when the temperature has been raised within a few degrees of the boiling-point of mercury. The following table presents at one view an approximative idea of the relative quantities of distillate obtained at intervals of 50°, 50°, 30°, and 15° centigrade:—

170° to 220° C.	=	338° to 428° F.	2.
220° to 270° C.	=	428° to 518° F.	4.
270° to 300° C.	=	518° to 572° F.	5.
300° to 315° C.	=	572° to 599° F.	2.
Above 315° C.		Above 599° F.	7.

The residual oil in the retort contained some quantity of solid paraffine. We have before alluded to the excellence of Albertite oil as an illuminating material and substitute for paraffine oil: the readiness with which it rises in the wick, and the whiteness of the light which it gives, are certainly remarkable, considering the very high inflaming and boiling-point of the oil. It would be a fortunate circumstance if Albertite should be found to exist in quantity in Scotland, as it unquestionably yields a mineral oil that for illuminating purposes is far superior to any hydro-carbon oil now in use.

The next meeting of the Society will be held on November 4th, 1863.

NOTES AND MEMORANDA.

KARSTEN ON ORGANIC CELLS.—Dr. Arlidge has published in *Annals of Natural History* a paper on the Development of the Organic Cell, by Karsten, translated from *Poggendorf's Annalen*. Among other statements, we find that "the cell wall is not simple, but composed of several cells placed one within the other, which are frequently regenerated from within outwards by the unfolding of the neuclear cell, and each of which cells passes through a course of development peculiar to itself. . . . . The so called nucleus is a nuclear cell. . . . . The so called constrictions or segmentations of the cell-nucleus belong in fact to the same category as the so termed germinating cells. These forms are produced by the excessive development of daughter cells in a fully vegetating parent cell which is in course of destruction. . . . . The rotation of the cell juices appears to be a mere phenomenon of diffusion—endosmosis co-operating on the one hand, and the property of assimilation possessed by the inclosing cell wall on the other, in a continuous act of intermingling the materials concerned."

CONTRACTILE FILAMENTS OF THE THISTLE TRIBE.—The *Quarterly Journal of Microscopic Science* contains a translation of a paper by Dr. F. Cohn on this subject. "Professor Cohn proceeds to remark that in the Cynareæ (or Thistle Tribe) the five filaments are inserted into the tube of the corolla, and support at

their extremities the anthers, which, as in all the Compositæ, are conjoined into a complete tube. At the time of flowering this anther tube is closed at the end, and envelopes the pistil which arises at the base of the corolla from the inferior ovary. At this period the anther tube rises about four m. m. above the summit of the corolla. When touched pollen masses are extracted from its apex, and at the same time the tube exhibits a peculiar twisting movement. After about five minutes the experiment can be repeated; the pollen is again forced out of the tube, and the twisting movement will be again witnessed." When the filaments are extended they appear as if longitudinally striated; when contracted, as if transversely striated. He considers the fibres to correspond in their behaviour *essentially* with unstriped muscle; but he regards their shortening as of a passive nature, and due to elasticity, and their lengthening an active condition which is the opposite to what takes place in muscular fibre. He considers that we may now be said to be acquainted with plants which, so to speak, have *muscles;* and in the lowest animals which possess no muscles their contractile parenchyma behaves after the manner of contractile vegetable cells.

RESPIRATION OF RUMINANTS.—In a paper which will be found in *Comptes Rendus* M. M. J. Reiset shows that a proto-carburet of hydrogen is emitted during their respiration. He regards it as arising from the changes which their food experiences during digestion. They likewise emit a small proportion of nitrogen. He shows that the consumption of oxygen and emission of carbonic acid gas goes on so quickly that cattle stables require much more ventilation than is generally allowed on old French farms—a remark equally applicable to many in this country.

FUNCTIONS OF THE EAR.—Professor Helmholz, author of an elaborate work entitled *Die Lehre von den Tonempfindungen*, regards the snail shell or *cochlea*, as the special organ for transmitting musical sounds to the nerves, while noises affect other portions of the ear. The so-called "fibres of Corti," of which there are about 3000, he considers each capable of being affected by a simple sound, while a compound sound acts upon several, and produces a corresponding impression on the nerves. Each filament of the acoustic nerve is united to an elastic filament, which he supposes to be thrown into vibration by appropriate sounds.

MUSCLES OF THE HEART.—*The Archives des Sciences*, No. 67, contains a brief account of Dr. Gartaldi's researches on this subject, and which are published in the *Wurzburger Naturwissenchaftliche Zeitschrift*. It appears that Weissman established a great difference between the muscles of the heart and other striated muscles. He demonstrated that the hearts of the invertebrata, of fishes, and of batrachians are composed of cells during their whole existence; while in reptiles, birds, and mammals, including man, the cells only exist during the embryonic period, and at a later stage are transformed into muscular fibres. Weissman thought this change took place by fusion of many cells, a theory not according with observations of Remak, Lebert, and Kölliker. Gartaldi's observations on the hearts of pigeons show that the muscular fibres do not result from the fusion of cells, but that they must be considered as primitive fasciæ. With respect to the nucleus he has always seen it in the axis of the fibre in the birds and mammals which he has examined, a character which is only found in the embryonic fibre of voluntary muscles, and he therefore concludes that the muscular structure of the heart in the vertebrata presents a phase of development inferior to that of the fibres of the muscles of voluntary motion.

BABINET ON THE LUNAR ECLIPSE, JUNE 1.—M. Babinet states in *Cosmos* that this eclipse presented a peculiarity not before noticed. When the moon left the earth's shadow and formed a crescent, whose greatest breadth was equal to one quarter of the moon's semi-diameter, the eastern half was illuminated while the western half remained in shade. This appearance lasted so long as to leave no doubt that at the end of the eclipse the shadow of the earth extended further on the western than on the eastern side of the meridian of Paris. M. Babinet explains the reason of this phenomenon as follows:—He states that at a pressure of seventy-six centimeters, the refraction of the atmosphere amounts to thirty-five minutes with regard to rays that reach us from the horizon, and seventy minutes for those solar rays which pass close to the earth's surface, and traverse

the atmosphere again before escaping behind the earth, and that thus the illumination of the atmosphere diminishes the earth's shadow by more than twice the diameter of the moon. The bent rays are the first to reach the moon as she emerges from the shadow. As the refraction is proportioned to the density of the air, those rays which traverse the atmosphere at a considerable elevation are less bent than those which pass close to the earth. On the 1st of June the solar rays passed over the earth's surface in the middle of Greenland. In the western part of the circle of illumination the rays traversed the air above glaciers which have an elevation of at least 500 meters, while at the eastern part they traversed the air close to the open sea, and having a refractive power of seventy minutes, that of the air above the glaciers being refracted at least four minutes less. This accounts for light reaching one part of the lunar crescent before the other.

AN INNOCENT GREEN.—*Cosmos* gives the following as the composition of an innocent green for house painting and paper hanging, and which ought to replace the poisonous arsenical greens. It is called "English green," and contains—

Sulphate of baryta . . .	0·780
Protoxide of iron . . .	0·040
Silica	0·088
Alumina	0·040
Soda	0·025
Lime	0·007
Water and loss . . .	0·020
	1·000

NEW PROCESS OF ENGRAVING.—*Cosmos* gives the following as the process of M. Dulos:—A plate of copper is covered with a varnish of india-rubber and zinc white. Lines are traced through this surface down to the metal by an ivory point. The plate is then plunged in a solution of hydrochlorate of ammonia, the positive electrode being a plate of iron in communication with the negative pole of the pile. Iron is deposited on all the parts of the copper exposed by the ivory point, but not on the varnish, which is removed by benzine. The plate is once more exposed to electric action in a bath of silver, and that metal is precipitated on the copper but not on the iron. It is then heated to 80° C., and an alloy fusible at that temperature is poured over it. The liquid moistens the silver and adheres to it, but not to the iron, which it does not moisten. When cold the fusible alloy will be found standing on each side of every line, and forming a mould, from which a new plate, adapted to printing, is obtained by a galvanoplastic process.

REPRODUCTION OF LITHOGRAPHS.—The following note from M. Rigaud has been presented to the French Academy:—"I apply the back of a lithograph to a layer of pure water for a few minutes; it moistens uniformly, and the water does not wet the black portions. I withdraw it and place it between two folds of paper to remove excess of moisture, and then stretch it face downwards upon a lithographic stone, to which it adheres by slight pressure. I then take a sheet of ordinary paper and moisten it with the nitric acid of commerce diluted with ten times its bulk of water. Removing the superfluous acid by two folds of paper as before, I press this acidulated sheet upon the lithograph. The nitric acid works its way slowly through the moistened lithograph, and acts uniformly on the stone with disengagement of carbonic acid gas, which penetrates the pores of the paper as fast as it is produced."

LIONEL BEALE ON NERVE CELLS.—Mr. Beale's researches lead to the conclusion, "1. That in all cases nerve fibres are in bodily connection with the cell or cells which influence them, and this from the earliest period of their formation. 2. That there are no apolar cells, and no unipolar cells in any part of any nervous system. 3. That every nerve cell, central or peripheral, has at least two fibres connected with it."—*Proceedings of the Royal Society*, No. 56.

P H Gosse. del

The Blue Cyanea

THE INTELLECTUAL OBSERVER.

OCTOBER, 1863.

THE BLUE CYANÆA.

BY PHILIP HENRY GOSSE, F.R.S.

(With a Coloured Plate.)

Of all the varièd forms of strange life which the prolific sea carries in her bosom, few are more calculated to attract and rivet interested attention than the *Medusæ*. Globose forms of translucent jelly, clear as crystal, or bearing alternate bands of frosted surface, like a lamp-globe of clear and ground glass commingled, colourless as the water which bears them, or dyed with the loveliest hues, moulded with the most elegant symmetry—they appear and vanish, now urging their solitary course with an unintelligible energy, now associated in immense groups, rising and falling helplessly on the lazy swell of the summer sea, now eluding the most diligent search. Whence they come, whither they go, why they congregate, why they separate, we know not. We land from the steamer in one of our western watering-places, and as we bustle about the pier, watching our luggage, we cannot help seeing that the surface of the little harbour is thronged with the elegant jelly-fishes. The oars of the busy boatmen push them about, or cut them through unheeded; they rotate with undignified agility in the swirl of the steamer's screw; they repose in motionless majesty between the piles of the wharf, where, as we look down perpendicularly upon them in the shadowed water, every line and every tint is discerned to advantage, and we wonder at their beauty. Or we take our stand on some rocky headland, and gazing into the transparent depth, see far below the surface a great sphere of painted glass, vigorously yet heavily making way by alternate pump-like expansions and contractions, and dragging in its oblique wake a tangled crowd of cords. Or, in the dazzling twinkling haze of an August noon, we take a pull in a boat a mile or two off shore, and, taking our station in the bow, break the glistening surface of the mirrory sea with re-

peated dips of a muslin ring-net, obtaining large material for wonder and admiration. Yonder, in the unbroken clearness, floats a globe of heavenly blue; carefully the net is lowered beneath it, and as we lift it out of water we marvel at its weight. It lies a shapeless mass of coloured jelly in the bottom of the strained bag; but we turn it out into the bucket of sea-water, drawn fresh and pure to receive it, and then, as it turns over, and gives two or three pumping strokes to prove its powers, we see that it is uninjured; and now, away to shore, that we may examine our prize at leisure.

On putting the creature into an ample glass tank, we discover that we have before us an object of singular beauty. It is of a somewhat mitre-like form, or that of two-thirds of a globe, with a slight tendency to constriction around the upper third, the diameter being about five inches, and the height about three and a-half.* On turning over the pages of Eschscholtz's *System der Acalephen*, the best work extant on these creatures, we have no difficulty in determining our captive to belong to the interesting and highly-organized genus *Cyanæa*.

This genus was established by Peron for such discoid Medusæ as possess tentacle threads and sac-formed appendages to the stomach, and whose tentacles are not arranged around the edge of the disk, as in the genera *Pelagia* and *Chrysaora*, but spring in bundles from the inferior area of the disk; while there are on the outer edge of the disk vascular processes of the digestive cavity. The sac-formed appendages are sixteen in number,† on the circumference of the stomach, of which eight broader alternate with as many narrower. These accessory sacs or pouches are formed on a quite peculiar model, for we meet with them in no other genus of discoid Medusæ: their under skin having numerous cross-foldings, lying closely side by side, which, as they appear united at both ends, form peculiar small sac-formed extensions of this skin. Within the cross-foldings there is a row of toothed vesicles, which probably secrete a fluid accessory to digestion—a gastric juice. The vesicles are so arranged that they constitute excentric rows. Though the accessory pouches appear on their exterior circumference as if cut off or closed up, owing to the last cross-fold, yet this is only apparent, for their cavity has many expansions at the border of the disk. In the first place there are sixteen processes of the pouches, whose bases are in connection with the outer angles of two pouches, immediately

* The figure in the annexed plate, which was drawn from a specimen in full health and vigour, represents the animal reduced to about half the natural size.

† Thirty-two, according to Eschscholtz (*Op. Cit.*, p. 67), sixteen broad and as many narrow; but his figures represent only half these numbers, and I can find no more in the specimens which I have examined. I suspect a verbal error in his text.

opposite the division between them. Each of these processes is closer to its neighbour on one side than to that on the other, owing to the alternate variation in the width of the pouches on which they are seated. Their form is much longer than wide, and they, too, are furnished with folds, which, however, run lengthwise, and contain rows of vesicles. From these processes the digestive cavity now expands on all sides, sending out ramifications to the margin of the disk.

The tentacles, which are slender threads of no great length, spring not from the edge of the disk, but partly from the outer margin of the pouches, and partly from that side of each process which faces its more remote neighbour.

Close around the orifice of the stomach, which occupies the centre of the inferior surface, arise four lips, which are thrown into strong longitudinal folds, but which, when extended, are seen to have a flat three-sided form. They do not cohere together so as to form a foot-stalk.

In full-grown individuals the germs or ova are apt to fall by their own weight out of the ovaries, and hang down in strings or masses between the folded lips.

There is enough in this diagnosis of the genus, which I have freely transferred from Eschscholtz, to enable us to identify our elegant specimen as a *Cyanæa,* while yet in several particulars there is a divergence. The pouches are very nearly of equal width; at least, though they vary slightly in this respect, there is no noticeable alternation of a wide and a narrow one in regular succession. Again, the diverging processes are but eight in number, of a semi-elliptic figure, each seated half on two contiguous pouches, its median line corresponding to the line that divides them. Possibly, however, this semi-ellipse may be resolvable into *two* processes placed side by side in close contact; the line of junction (if of two), or the centre (if of one), being immediately opposite the curious little eye-sac, which I will presently describe.

As to the species, I have some difficulty. Eschscholtz has described but four: of these, the *C. ferruginea,* of Behring's Straits, and the *C. rosea,* of the Australian seas, may be set aside at once: there remain *C. capillata* and *C. Lamarckii* of our own coasts. The former of these, with its great tawny disk and lips, its stomach-pouches alternating in width, but about equal sided, and their long, narrow, parallel-sided, obliquely truncate processes, may also be dismissed. There remains, therefore, but *C. Lamarckii,* and with this our captive tolerably well agrees. The Prussian zoologist describes this species as having its disk covered with indistinct large flat grains, and of a whitish tint, but so faint as to be hardly perceptible. The margin has eight deep incisions, which separate as many broad

three-sided flaps, a little bowed at the sides, and rounded at the end, where there is a slit for the supposed visual organ. The inferior skin of the stomach, and of its folded pouches, is of a transparent grey hue, but the inner surface of these parts, which is inclosed in the disk-mass is blue; and this, sinking in many places into the disk-mass by the contact of two coloured surfaces, gives origin to many blue lines. "Thus we perceive over the centrally-placed stomach a somewhat indented blue circle, and within the same a net of such skin-folds. From this circle proceed sixteen rays,* each of which lies immediately over the median line of one of the accessory pouches." In the specimen which I have figured, when viewed vertically from above, the whole area bounded by the outer edge of the pouches is of a rich translucent blue, of which the central portion, corresponding to the circular orifice of the mouth, is of the deepest intensity; while from this deeper part *twenty-four* slender bands of *whitish* radiate to the well-defined edge of the lighter blue, one proceeding to each of the eight principal incisions, and one towards a point some distance on each side of the visual organ. The lips or furbelows are short, folded strongly, and overlapped at the edges. The tentacles in Eschscholtz's specimen were white. Lamarck describes them as blue; mine agree with the latter, for they are of the same full clear blue as the disk. These organs, originating as before described, constitute eight groups of about forty tentacles each, which are graduated in length, the largest being in the centre of the group, the shortest at the extreme sides. The actual length, however, varies considerably, from an inch to six inches or more, at the pleasure of the animal, as they are very contractile and extensile. As usual, these organs are roughened by the presence of tubercles, which are densely-crowded groups of *cnidæ*, or thread-capsules, twenty to fifty in each, so closely set as to be in actual contact. The cnidæ are mostly of a short oval form, from 1-1800th to 1-10,000th of an inch in length, each containing a chamber occupying about half of its volume. The ecthoreum or venomous thread is of great length; I traced one to 1-18th of an inch, or a hundred times the length of its cnida. The cnidæ of the furbelows are much larger, some reaching to 1-1000th of an inch, with a linear chamber; they are scattered throughout the gelatinous expansion of these appendages, but are mostly aggregated at the edges, which are thence slightly thickened. The stomach-pouches are somewhat hollowed in the outline of their exterior border, so that their angles project.

A very conspicuous feature in this Medusa is the presence of great arched folds into which the outline of the disk is thrown. These are sixteen in number, eight wide and tall,

* Also said to be blue ("*radiis sedecim cyaneis*") in the specific character.

corresponding to the deeper incisions of the margin, eight narrower and lower, corresponding to the incised points of the flaps. The folds of gelatinous membrane which constitute these arches are very complex, and both sets are the seats of elaborate ramifications of the canals that proceed from the digestive cavity, and carry water, charged with nutrient particles and with oxygen for respiration, to the exterior of the system. Up each side of the greater arches the ramification takes the form of a succession of loops seated on the marginal canal; whereas, to the summit of each smaller arch proceeds a straight canal, which sends off from each side a series of curved cœcal processes, like the beards of an elegant feather. The point of the canal which would represent the quill of this feather merges into the singular little organ which we must consider as performing the function of an eye.

These organs are extremely interesting in their structure, and are worthy of more attention than is usually bestowed upon them. They occur in certain genera of Medusæ, which in other respects have a higher organization, and are always protected with these hoods of membrane, whence such genera have been grouped together under the title of *Steganophthalmata,* or Covered-eyed; while other zoologists have associated them with the family *Lucernariadæ,* as an order named *Lucernaridæ.**

In each genus the organ consists of a round or ovate body, of an opaque red or yellow colour, pendulous from the summit of the protecting hood, or arched fold of membrane at the edge of the disk. It is connected with the disk by a slender footstalk, into which one of the canals passes as already described; the interior of this pedicel being delicately ciliated.

* Professor Greene's *Manual of the Cœlenterata.* Surely a most objectionable designation; for the termination *idæ*, changed to *adæ*, when the noun is of the first declension, or ends in *os purum* (equivalent to *ius*, *eus*, etc., in Latinized forms)—the Greek patronymic—has been accepted by zoologists as the distinction of *family* rank; and to form an *ordinal* appellation, including the family, on the same model, is most irregular, and only productive of confusion. Indeed, the form *Lucernaridæ* is incorrect, since *Lucernaria* being of the first declension, the only patronymic that can be formed of it is *Lucernariadæ*. I will use this opportunity of adding a word on the usage of naturalists in constructing family designations. If the rule I have just mentioned is the true one, such forms as *Pelagidæ*, *Oculinidæ*, *Colidæ*, *Rhizostomidæ*, are incorrect, and should be rejected; the first two should be *Pelagiadæ* and *Oculinadæ*, the terminal *a* of the component noun being changed into *adæ;* the third *Coliadæ*, because Colius (= *os purum*) of the second declension makes its patronymic in *adæ;* whereas the fourth should be *Rhizostomatidæ*, since *stoma* is not of the first but of the third declension, and forms its patronymic from the genitive. Some naturalists, who are competent scholars, form the termination always in *idæ*, believing the rule to have reference to εἶδος, resemblance. I have, however, the best authority for stating that at the first proposal and adoption of the termination *idæ* for zoological families, at a meeting of the Zoological Club, composed of the late Mr. Vigors, Professor Bell, and two or three other eminent naturalists, whose names I cannot now with certainty mention, the construction of the Greek patronymic was the rule accepted, and that a compound of εἶδος was not even thought of.

The ovate organ, so exquisitely fashioned, so liberally furnished, and so carefully shielded, presents a beautiful appearance when viewed as an opaque object under a strong light, reflecting a fine yellow colour, and displaying the regularly-shaped extremities of transparent and colourless prisms with which it is filled. As long ago as 1816, Gäde* defined these prisms, and some years afterwards Rosenthal† perceived them to be hard corpuscles, and supposed them, *since they did not effervesce with acids*, to be atoms of silicious earth or sand.

Still later (in 1834) Ehrenberg submitted these marginal organs of the Medusæ to an elaborate examination, the results of which he gave as follows:—"The hard bodies are most regularly crystallized, water-clear forms, of the crystallization of the quartz-system; namely, six-sided, short, sometimes nearly globular columns, with a doubly-three-sided or six-sided point. Often they are regularly equal-sided, or longish six-sided tables, like those formed of carbonate of lime; not seldom they are long six-sided rods, with unequal flat points; but always quite distinctly, almost regularly, crystalliform." The learned professor then proceeds to tell us how he poured sulphuric acid on the whole sac, with no perceptible result; how then he crushed down several sacs together, and heated the mass with the same acid, and how the crystals were instantly lost amidst the formation of bubbles. He concludes, therefore, that the prisms are veritable crystals effervescing with acids, and probably consist of carbonate of lime, similar to those which he had previously discovered in vertebrate animals, in connection with the nervous centres.‡

Thus the inorganic earthy crystalline nature of these bodies appeared to be established; and in the latest work on the anatomy of these creatures—Professor Greene's *Manual of the Cœlenterata*—the term "lithocyst" is used for the prism-filled sac, and the prisms themselves are described as "crystalline." Yet I am bold to affirm that this is an error. As long ago as 1856 I stated, on the ground of my own examinations, a different conclusion. "It does not appear that these bodies are silicious, ... or that they are crystals of earthy matter at all, but rather that they are composed of hard transparent organic tissue, analogous to the crystalline lens in vertebrate animals. When treated with *liquor potassæ* they speedily became amorphous and dissolved into a turbid fluid. Another lot, immersed in nitric acid, dissolved in like manner, acquiring a slight tinge of green during the process. Not the slightest effervescence or disturbance was visible by the most careful watching under either treatment."§

* *Anat. u. Phys. der Medusen*, pp. 18, 28. † *Zeitsch. f. Phys.*, 1825, p. 326.
‡ *Müller's Archiv*, 1834, p. 574. § *Tenby*, p. 174.

Since the publication of these observations, I have had additional proof of the non-earthy character of the prisms; for having mounted some, carefully cleansed, on several glass slides, and covered them with plates of thin glass, for future microscopic observation, I found, after some months, that they had wholly disappeared, leaving scarcely a trace of their existence, though exposed only to the atmosphere, and this admitted only under the edges of the plates of glass. If they had been earthy crystals, it is manifest that they would have remained unchanged both by the atmosphere and by potass.

The specimen whose portrait accompanies this little memoir lived for two or three days only, in a glass vase of sea-water. Generally I have not been able to preserve these forms in health for a longer period; though a fine specimen of *Chrysaora cyclonota,* whose history I have given elsewhere,* lived under similar circumstances about three weeks. A very gorgeous object was the *Cyanæa* in captivity. The whole umbrella was of a fine rich blue, possessing a sapphirine brilliance and transparency, especially when the slanting rays of the setting sun shone horizontally through the mass, as it floated in its glass prison on our drawing-room table. This hue was deepest where the substance of the disk was thickest, while at the surface and edges it melted off into colourlessness. Yet the lower integument or sub-umbrella, being of a far deeper colour, the form of the inner dome, viewed horizontally, was quite broadly defined from the hue of the mass, and seemed like a solid hemisphere of glass within the mitre, of a blue so intense that the sun's rays could scarcely struggle through it. In this the vault-like clefts were fashioned, reminding us of those beautiful paper-weights, in which some exquisitely folded pattern is seen within a perisphere of smooth clear glass.

It was interesting to observe that by lamplight the hue was very different. As I have often noticed that flowers which by daylight are almost purely blue, show by candlelight a prominent red element, before unrecognized, so this fine Medusa became of a fine imperial purple. I suppose the explanation is, that the blue ray is more weakly perceptible by artificial light, and is, therefore, overpowered by the red ray, though this may exist in the compound tint in actually a less ratio.

I could not detect any stinging property in the tentacles when touched by the hand. Its congener, *C. capillata,* is described as so formidable as to be the terror of bathers; and Edward Forbes has given us a graphic description of an unfortunate swimmer writhing, terrified and tortured, in the clinging grasp of its slimy threads. Much may depend on the varying susceptibility of the human skin to the poison in different per-

* *Devonshire Coast,* p. 363, *et seq.*

sons. Only a day or two ago I was engaged in capturing some lovely specimens of *Chrysaora;* a lady of my party, in lifting one, complained of being stung, while I lifted them without the slightest sense of such a phenomenon. So it is with some Anemones, the tangled snake-like locks of *Anthea cereus* may be handled by a man with impunity, while the tenderer skin of women and children smarts and reddens with the contact.*

* The subject of the poison-apparatus in a kindred group of animals I have treated in considerable detail in my *Actinologia Britannica* (Introd. pp. xxii.—xl.) I hope it may not be considered out of place if I here cite some observations of an American zoologist, confirming some of the most important of my conclusions, and adding other information of much value. Professor Henry James Clarke, of Harvard University, Cambridge, Mass., in a very able article, entitled "Lucernaria, the Cœnotype of Acalephæ," describes the cnidæ of this organism in the following terms:—

"The nettling organs or lasso cells, which crowd the globular tips of the tentacles, are of two kinds, and both are imbedded in the intercellular substance which fills the spaces between the columnar cells of the outer wall. One kind consists of an oval, thick-walled vesicle about 1-2000th of an inch long, or a little less, one end of which is introverted and projects in the form of a stout hollow shaft along the axis of the cell, about four-fifths of its length, and then, rather suddenly thinning into a slender thread, which is also hollow, it bends upon itself, returns nearly to the aperture of the cell, and, pressing closely against the inner face of the cell-wall, it forms a close coil, which terminates at the end opposite the mouth of the introversion. When the coil of thread is ejected, which is accomplished by sliding through the hollow axial shaft, which, in its turn, retroverts also, just as the finger of a glove is turned inside out, the whole aspect of the apparatus is changed. The oval cell is considerably diminished in size, and from its aperture the enormously enlarged hollow shaft projects in a straight line; the half of the shaft next the cell is cylindrical, and half as broad as the latter, with a slight expansion where it joins the mouth of the cell; the distal half abruptly expands into an oval form, half again broader than the cylindrical portion, and rapidly tapers into a smooth trihedral, twisted thread. The oval part of the shaft is endowed with three equidistant spiral rows of setæ, which number about a dozen in each row. The setæ are comparatively large, and in length equal two-thirds the broadest diameter of that part of the shaft from whence they project. Each row makes but one turn above the shaft, and terminates as if in continuation of the angles of the trihedral thread. There is not the least trace of setæ or projections of any kind upon the trihedral thread, but it continues, with a very gradual taper, perfectly smooth to the blunt termination. The angles of the thread appear, at first glance, as if they might be spiral rows of setæ; but a most careful and prolonged examination with one of Spencer's ¼-inch objectives convinces me that they are truly the angles of a twisted trihedral filament. The extent of the thread is from twenty to twenty-four times the length of the cell. The other kind of nettling cell is much more simple in structure, but yet more remarkable. The introverted shaft is very slender, in fact no larger than the rest of the thread. It does not project into the axis of the cylindrico-oval cell, but presses close to the side of the latter, and extends four-fifths of the way to its opposite end, and then, bending abruptly upon itself, the thread passes with a long curved sweep nearly to the aperture of the cell, from whence it again returns with another long sweep, which is repeated eight to ten times, until the inner face of the cell-wall is lined by a close coil which winds lengthwise instead of transversely, as it does in the other kind first described. When extended the thread is from twelve to fourteen times the length of the cell. It offers not the least sign of appendages of any kind, but is simply a smooth round filament of uniform thickness throughout, except at the end, where it tapers slightly and terminates in a blunt tip. The cell itself, when retroverted, is sensibly diminished in size, and narrows rapidly into the prolonged filamentary portion. It would

FALLING STARS AND METEORITES.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

FROM the earliest times—long before men had any idea of the calculations of astronomy, of the difference between planets and fixed stars, or of the vast distance of the nearest star not only from the earth, but from any part of the solar system—the singular phenomena of falling stars had been noticed, and had connected themselves with feelings that will probably never be entirely eradicated from the minds of men. Thus in the same ancient Jewish history that tells us "the sun stood still, and the moon stayed," in order that Joshua might destroy a few more of his fleeing enemies, we read also, "the stars in their courses fought against Sisera." Both these expressions are probably intended as no more than oriental pleonasms, but they indicate strongly the unalterable egotism of man, who will to the end of time regard himself and his affairs as the ultimate object of divine care.

When, therefore, on the tenth of August last, the usual annual shower of Nature's rockets was seen in the atmosphere —this storm of silent flashes and darts of light, mysteriously shooting from one point of the heavens towards another point, some with bright trails of light, some as fiery balls, some darts and arrows of light, and not a few ending as the rocket with an additional shower of sparks—many, perhaps, who were unaware of the natural history of these objects may have fancied that some extraordinary crisis was about to take place in American politics, or that Europe was about to be convulsed by the refusal of Russia to treat the Poles as anything but wild beasts. For a very long time, however, the corresponding date, and also the 12th November, and several other days in the year, have been remarkable for an exhibition of the same kind without political consequences.

Kings have been born and died; revolutions have been commenced and carried out in human affairs; battles have been won and lost, but the day of the shower of falling stars has not much altered, though the clear sky has sometimes favoured, whilst at other times the clouds have concealed, the mysterious operations of nature.*

seem to be perfectly incontestable that, as the cell diminishes in size with the expulsion of the thread, it forms the propelling power, and, by the contraction of its wall, forces its contents outward."—*American Journal of Science*, May, 1863.

* It is a remarkable fact that in some very ancient records the date assigned to the phenomenon is many days earlier, even so early as the 25th July. In Thessaly there is a tradition that the heavens open and lights appear on the festival of the Transfiguration (6th Aug.) The reason is obvious. The civil time we

That the great crowd of falling stars is seen chiefly on the two occasions whose dates have been just given, is unquestionable; but they are also numerous on the nights preceding and following the principal ones, and they are visible, though less frequently, during every fine clear night throughout the year.

Few subjects are more interesting than the inquiry into the meaning of these appearances, and they have from time to time been noticed in these pages. Within the last few years there has been an enormous quantity of material collected, both concerning the actual history of showers of stones and meteors, and the details of remarkable examples. Few who have not followed the course of inquiry are aware how much material exists, how frequent and portentous the larger instances have been, and how very much positive proof there exists of the materiality of some, at least, of the phenomena, in the existence of many hundred well-authenticated specimens of fallen stones in several of the principal museums of Europe. A few accounts of remarkable cases will be both interesting and useful in preparing the reader for a consideration of the explanations that have been offered for the various facts recorded.

And, first of all, with regard to the number of these appearances. In the present year, at Cambridge, nearly a hundred meteors were counted by a single observer in one part of the heavens between 10 P.M. and 1 A.M. They were most abundant towards midnight. On another occasion, some years since, 565 were counted on the corresponding night, but this was by six observers, each taking a part of the heavens, and continuing the observations for five hours, from 10 P.M. to 3 A.M. There has hardly been an occasion, when the sky was clear, on which a very large number of these curious appearances have not been seen on the nights now known to be rich in them. On other nights they are occasional, but on these they succeed each other rapidly. It is not reasonable to suppose that they are limited to the hours of darkness, and thus it becomes probable that uninterruptedly, during certain days in the year, and at all other times with less regularity, and to a smaller extent, these lively messengers are constantly communicating between the world and the outer space; these visible messages along the telegraph of space are always reminding us that our earth is not wandering in a solitary path, but is surrounded by myriads of small fragments of matter, made visible when they pass through our atmosphere, or when we pass near them in their course.

There are two distinct classes of phenomena connected with

use does not correspond exactly with sidereal time, and the phenomena thus appear to occur gradually later and later in the year, though the intervals between their recurrence is really the same.

the subject of meteors. These are, first, the phenomena of light —the falling stars—as seen in the atmosphere; and secondly, the fallen bodies themselves, whether called meteorites, aërolites, fire-balls, bolitos, or thunderbolts—the fragments of foreign matter now and then seen to fall on the earth from the sky, but more frequently found near the surface, and identified by their peculiar mineral characteristics.

The meteors are of various kinds, so various that it is almost impossible to bring together within a limited space such an account of different records as shall give even a faint idea of the appearances described by those who have seen them. Limiting ourselves to the remarks of astronomers, and persons fully accustomed to observe and describe what they see, we yet find accounts as strange as if they were dreams of sick men.

The vast majority of the strange lights seen in the heavens are well described by the expression, Falling or shooting star. Suddenly a star, or what appears a star, shoots rapidly from one point in the heavens to another, or seems to fall downwards towards the earth, and disappear. Of such phenomena, whatever they are, it is not too much to say that thousands sometimes take place within twenty-four hours; that on special occasions this number may be multiplied many fold; that they are common even at all other times, and that, in fact, they are as little exceptional as clouds. It is impossible to identify and measure any particular one, for they are too frequent and too much alike. They are seen from every part of the earth's surface almost every fine night throughout the year, in every quarter of the heavens, and there cannot be the smallest reason for supposing that they do not occur by day as well by night, in foul weather as well as fair.

Of these ordinary shooting-stars, special observations are made at certain dates, because they are then most numerous and most definite. At such times, as we have seen, they are counted by the hundred, often by hundreds in the hour, in all the principal observatories, and by many private individuals. On such occasions they appear, most of them, but not all, to proceed from near one point in the heavens, and disappear in another. These points are generally the same.

Of the size of these meteors it is impossible to give any correct idea. It is usual to compare them to the stars, and speak of them as resembling stars of the first to the third magnitude. It seems quite impossible to judge even relatively of their actual dimensions by observations of this kind, even when for any reason it has been possible to estimate their height.*

* An ingenious and very simple instrument for estimating the altitude of these bodies was described in the INTELLECTUAL OBSERVER, vol. iii., p. 165.

Passing on now to the more remarkable and rarer meteors we find statements of the most singular and even contradictory nature. There is much that is interesting and instructive in these accounts, though when forwarded by observers not accustomed to astronomical descriptions, they require a certain amount of correction.

The simplest complications of an ordinary shooting-star are an apparent curvature, a serpentine course, or an apparent interval of repose in the course; a distinct line of light or train left behind in the sky, and a bursting of the star before it disappears, leaving behind a multitude of small stars precisely resembling an exploded rocket. All these are common. The rarer appearances will be noticed presently.

The duration of the phenomenon is another matter also very interesting in certain cases. While ordinary meteors are over almost before one has time to be sure of their existence, and note their size and direction, others move slowly. Trains remaining visible for several tenths of a second, for one or even two seconds, are exceptional, but not very rare. Now and then, however, the meteor lasts for a minute. Much more remarkable cases are, however, recorded. Thus, on the 7th January, 1856, at 4·50 P.M., a fire-ball appeared in the sky in the South of England, being seen at various places between Wiltshire and the east of Kent. The sky was clear, and the fire-ball appeared to burst out from the sky as a brilliant globe of light. It remained visible everywhere for more than ten minutes before it finally disappeared. In Wiltshire it was seen for twenty minutes, at Brighton for fifteen minutes, at Sevenoaks for ten minutes, and at Blackheath for the same time. Its size was estimated at four times the diameter of Jupiter. In most places it suddenly appeared from the clear sky, but at Blackheath it emerged from, and was lost behind clouds. This very remarkable meteor is one of the best and most distinctly recorded of those which have been seen at great distances apart, and which, being seen for some time, could be clearly identified.

Many of the meteors appear coloured, and the colours are very varied. Bright emerald blue, intense blue, orange, greenish and red, have all been described; and, as may be supposed, there are abundant shades of each. Upwards of a thousand coloured shooting-stars were distinctly recorded as observed in England in the sixteen years from 1840 to 1855, and records of about a thousand have also been collected from China. Of the former, upwards of half were yellowish red, and a third whitish blue. Of the latter, about one-third were pure blue, a sixth pure yellow, and about the same number pure red. Of larger meteors or globes, it has been recorded that about 700

probably fall annually on the earth. These move more slowly than the smaller stars, and they exhibit several colours in their course, but are generally blue towards the horizon. Many of them change colour, and others suddenly burst into a multitude of small stars, or into a kind of vaporous cloud of peculiar tints. Some emit coloured light vivid enough to redden or colour the surface of the earth. It is a remarkable fact, often noticed, that these meteors are unusually bright when seen through an aurora borealis.

The great majority of meteors appear to proceed from some point in the East, but this may be owing to the relation between the earth's motion in space and that of the meteors themselves.

The heights of meteors that have been subject to actual calculation lie apparently for the most part between sixteen and one hundred and forty miles, though some reach two hundred, and some as much as four hundred miles, while some appear to be not more than four miles from the surface at the commencement of their course. Their velocity is less accurately known, but has been estimated as generally double that of the earth in its orbit. Herschel, however, assigns velocities varying from eighteen to thirty-six miles per second for ordinary meteors, and states that some appear to travel at the rate of ninety miles per second. The earth's motion in its orbit is between nine and ten miles per second.

The passage of meteors is sometimes, though rarely, accompanied by noise, and in that case it is probable that some solid body explodes in the air and falls to the earth. Falling stars are thus connected with these remarkable aërolites, or meteoric stones, specimens of which are to be found in several public museums.

As one of the most remarkable and complete accounts of the phenomena of meteorites that has been placed on record, I add an abstract of an account published in the *American Journal of Science*, vols. xxv. and xxvi., of appearances observed over a wide area on the night of the 12th and early morning of the 13th of November, 1833, one of those dates at which the largest number of falling stars have generally been observed in America as well as England.

The meteors on this occasion first attracted notice by their number and brilliancy about nine P.M. on the 12th of November. At eleven o'clock they were very remarkable, but became most brilliant about four A.M. of the 13th, and continued with little diminution till broad daylight, after which a few large fire-balls were seen, their light being more intense than that of day. The area over which similar phenomena were seen extended from longitude 61° to 100° west, and from the North American lakes to Jamaica. "Everywhere within

these limits the first appearance was that of fireworks of the most imposing grandeur, covering the entire vault of heaven with myriads of fire-balls resembling sky-rockets." There were, however, three varieties, the first consisting of lines of light, the second of defined fire-balls, and the third of ill-defined luminous bodies. The two latter remained for some time visible. All appeared to emanate from a point in the constellation Leo, and this point retained the same relative position among the stars during the whole night. The greater number of the meteors described an arc of 30° or 40° with some rapidity, but the undefined bodies lasted in one case for more than an hour. One of the fire-balls was heard to explode with the sound of a cannon, and slight explosions, with occasional hissing noises, were heard from time to time during the night.

Among the phenomena attendant on these lines, points, and globes of light, which sometimes evidently change their state, and burst in the air, are falls of stones and other substances. Thus on the 4th of May, 1858, an ignited globe was seen in the air, which fell down into a farm-yard, exploding with a loud report. A smell of sulphur was perceived, and incandescent fragments flew in different directions, one of which hit a cow. The straw was disturbed and turned up where the globe was seen to fall, but it was not burnt, and no hole was seen in the ground. This occurred in Buckinghamshire, about six miles north-west of Aylesbury, at the village of Quainton.

In the year 1860, there were several occasions when remarkable and brilliant appearances were seen in the heavens, followed by showers of stones falling on the earth. On the first of May in that year, about a quarter to one in the morning, a brilliant meteor, almost as large as the moon, was seen. It had a tail equal in length to twelve diameters. The whole moved on from S.E. to N.W., apparently falling, and was seen for three seconds. During and after the time when it was visible, a number of distinct explosions were heard, of which twenty-three were counted; other sounds followed like salvos of musketry, the whole duration of the sounds being two minutes.

This meteor was seen at places distant about twenty-five miles from its direct path, and the detonations were heard over an area nearly eighty miles in radius. It was estimated to be about three-eighths of a mile in diameter, and to move at the rate of four miles in a second.

When at a height above the earth of about forty miles it exploded, and black stones fell through the clouds with a whizzing sound directly after the explosions. Thirty of the stones were found on an area about ten miles in length by three in width. Of these stones one weighed 103 lbs., others half that

amount or less, the largest being furthest in the direction in which the meteor was passing. All these stones were angular. These phenomena occurred in the Northern States of North America.

On the 20th July, in the same year, two meteors were observed, both exceedingly brilliant; one apparently moving from east to west, another from west to east. The latter was seen over a length of 1000 miles of North America, shortly before ten o'clock at night. It is thus described:—"At first a single ball, it afterwards divided into two in about three minutes, the breaking up being accompanied by a report, and followed by a train of sparks and fire. Its colour was blueish; it was very brilliant, moved extremely slowly, and seemed almost to traverse the entire heavens; it seemed very near when almost overhead. Its absolute velocity in space was calculated to have been twenty-six miles a second." At its nearest approach to the earth it was calculated to be about forty miles distant. The distance of the first ball from the second, after dividing, was estimated at two miles.

In other parts of the world similar wonders have been described. Thus, on the 28th July, in the same year, in the north-eastern part of Lahore, in India, a series of shocks and explosions took place in the air, followed by flames (?) of fire and a great shower of meteoric stones, which ploughed up the earth.

Near home such events also occur. Thus, on the 5th of November, 1851, at half-past five in the afternoon of a clear day, a brilliant fire-ball was seen high up in the air near Tarragona, in Spain, and in the neighbourhood, over a distance of sixty miles. It had a luminous tail, which changed to a misty cloud, and lasted twenty minutes. Forty seconds after the fire-ball had disappeared a tremendous noise was heard, and many stones fell. One was picked up weighing 19½ lbs., and others smaller. They were picked up hot, and were coated with a black crust.

Such balls of fire bursting with loud reports, and connected with falls of stones reaching the earth, and subsequently found where they were supposed to have fallen, are comparatively rare, involving, as they do, the complete history of an event which always happens unexpectedly, and which generally astonishes and alarms too much to admit of careful investigation. But although not common, they recur constantly; few years pass by without a record of something of the kind, and each particular case presents its own peculiar phenomena, while assisting in some measure to clear away some of the difficulties experienced in the endeavour to account for them.

As a further illustration of similar phenomena seen in Eng-

land and very carefully recorded, we may take the following:— "On the 17th December, 1852, at about five o'clock in the morning, during a severe gale, a very remarkable cloud, that had been noticed for five minutes advancing in the wind's eye, and rapidly increasing in size, was noticed to give off a number of flashes, accompanied by a singular hissing noise, like that of a shot, clearly distinguishable from the howling of the wind. In the centre of the cloud a dull red obscure nucleus, or fire-ball, was seen, about half the size of the moon, having a tail five or six times that length, from which flashes were sent forth with great brilliancy, the sounds becoming more detonating as the meteor descended through the air. At three minutes past five the nucleus suddenly exploded, with a report similar to a very heavy clap of thunder, giving out an intensely brilliant light, which rendered the minutest objects distinctly visible, although it rained at the time violently and the sky was obscured. The body of the meteor seemed to fall into the water about half a mile from the land, and was indicated by a great volume of spray which rose foaming in the distance.*

The meteoric stones that exist in a state capable of clear identification, without being directly connected with any recorded meteors, are very numerous, and are found in all parts of the world. As might be expected, however, they are rarely noticed in countries where the land is cultivated and stones kept out of the way. The countryman ploughing his land would certainly not remark anything of the kind, and the scientific man would not go into a ploughed field to make mineralogical discoveries.

Very large and fine collections of meteorites exist, however, in some of the public museums of Europe. The British Museum is especially rich, and may be examined with great advantage by the student. Space will not allow of any account of these specimens, but perhaps a few notes made last year by myself on the Vienna collection, which is certainly the next largest, and is especially rich in earthy varieties, will interest the reader. It should be explained beforehand that there are two kinds of meteoric stones—those that are almost entirely metallic, and those which consist very largely of sandstone and other earthy minerals. The former are, perhaps, the most common, but the latter are in some respects the most instructive.

The Vienna collection of meteorites is remarkable for the variety of the localities that have yielded specimens to enrich it. The collection includes portions of stones that have fallen in one hundred and seventy-five different places, and among them are many of extreme interest.

* *Proceedings of the Royal Society of London*, for January 27, 1853, vol. vi., p. 276.

The interest divides itself into three subjects, viz., the nature of the material, its form, and the appearance and condition of the surface and of the interior of the mass.

A large proportion of the specimens are of a curious mixture of iron, nickel, and other metals, frequently regarded as peculiar to meteorites in whatever the part of the world they have fallen, or whatever interval has elapsed since their fall. The other specimens are chiefly fragments, some containing scarcely a trace of iron, and others a little iron, but most of them consisting of either felspathic or silicious sand, cemented together rather loosely. The appearance is extremely similar to that attained by sand after very long exposure in a furnace. The sand is compacted into a sandstone, but the grains are very imperfectly cemented. The outside of these specimens is almost without exception black, and has every appearance of having been fused. The size of the block is various; some are pebbles, not much larger than a walnut, others are as large as a man's head; some are broken fragments. One of them is very curious, as it exhibits distinctly the cause of the smooth surface. That side of the pebble which met the air (the part that is in the direction of progress) in the rapid transit of the stone through the air, is perfectly glazed, and the glaze has run over the edge; the rest, however, is only slightly glazed.

The surface of the metallic meteorites is especially remarkable, and there are many cases in which the crystalline form can not only be recognized as an outline, but may even be measured. The usual shape of the crystals is the octahedral. In some the outside is a mass of crystals of moderate size, greatly rounded, but still recognizable. These are the larger specimens. In others of smaller size the form is more distinct and less altered by weathering. Some, however, are completely rounded externally, and give no appearance of crystallization until broken. One specimen of large size has been partly sawn and then broken. The fracture in this case marks, in the most striking manner, the crystalline state of the mass, as it gives a repetition of parallel faces along the whole length of the broken part, amounting to five inches.

The external form of the non-metallic meteorites offers nothing very remarkable, beyond the fact of the peculiar rounded surface, apparently caused by great friction—a friction which can only be due to the passage of the mass through the air at an extremely rapid pace. The internal fracture differs nothing from that of a lump of similar material on the earth. The melting that has taken place at the surface, resulting in a deep brown or black glaze, is of no great thickness, and is strictly superficial.

The internal structure of the metallic masses is curious in

many ways, and the peculiar markings, caused apparently by the crystalline condition of the metal, are often very beautifully shown by irregular oxidation. Some specimens are covered with lines, parallel, and crossing each other with extreme regularity, resulting in a beautiful pattern. Others are less regular, but equally beautiful. Many have smooth blebs in the interior, hollow spaces once filled with pyrites which have fallen or decomposed out, leaving a perfectly smooth cavity. In some, real stones or foreign substances, more or less different from the mass of the meteorite, are buried within the mass; some are enclosed, and show from their angular surface how completely foreign they must have been; others are only partially buried, portions of them being outside. It is difficult to conceive how these may have been packed into their places.

One of the most singular of the specimens is part of a stone that fell at Tula, in Russia, in 1846. The crystalline structure was first observed in polishing a part of this specimen, which weighs 71 lbs. The original mass weighed 542 lbs.

The stones have sometimes fallen in showers. This was the case in France with some of those that have no metal, but consist almost entirely of felspathic stone. In the national museum at Prague are several large meteorites, one of which is a stone seen to fall. It is entirely melted on one side, and unchanged on the other. The melted side is quite round and smooth, and is black to the thickness of about one-sixteenth of an inch.

The various facts above stated are but a few out of a rich variety in reference to this curious subject, but they are sufficient to suggest some considerations as to their meaning, and also as to their bearing on the condition of those vast spaces that occur between the recognized and known bodies that make up our planetary system. It is an idea, not a little startling, when first presented, that besides the planets long known, and those distant ones recently discovered, and scarcely visible to the naked eye; besides those numerous asteroids or minute planets, almost all discovered during the present century, but whose number is constantly increasing, and will soon perhaps mount to a hundred; besides the satellites, which are much more numerous than was once thought; besides those wandering comets, sometimes whirling with incredible rapidity close to the sun, and then passing off for centuries or even thousands of years, lazily traversing space as they cross the orbits of the various planets, and sometimes reaching the outskirts of our system, far beyond the most distant known planet;—that besides all these, there are also belts consisting of numberless smaller fragments of matter, some metallic, others earthy, and only made evident to our senses when by some chance they enter

within the limits of our atmosphere, or when we approach so near them that they suddenly become incandescent, and glow with intense brilliancy for a few brief seconds.

There is hardly any rational way of escaping from this conclusion, that all space must be as thickly peopled with these fragments as is the air in a room with particles of dust. When the rays of the sun shine in through a narrow chink, all these minute particles in the course of a ray are made evident, and so these atoms of the dust of space are from time to time seen, not indeed when the sun is shining, but when in the dark but clear nights we watch the heavens, and note all the shining points that shoot out from the blue vault, and seem to disappear as they came. Probably, in the majority of cases, where there is merely this momentary line of brilliant light, the atom has been made bright by the friction produced, and heat evolved in passing through the thin air overhead. Heated intensely, the whole has become dissipated, being either broken up or oxidized into particles quite invisible. In other cases, where the magnitude is greater, the time longer, and the phenomena more marked, a sensible mass of matter is caught up, and though attracted by the earth and approaching its surface, yet fails to reach it, being also broken up into minute fragments of dust by the enormous friction met with before it can reach the actual land and sea. That in their course downwards these masses are occasionally swayed about, taking a zigzag or irregular path, seems certain, and now and then the actual broken fragments are seen to approach the earth, though they cannot be picked up on the spot where they appeared to fall. Now and then, however, a giant appears—a Triton among these minnows of the sky; molten on the surface by the friction, it yet succeeds in retaining its natural state, until at last it falls to the earth a solid, though rarely in an unbroken state. Masses of magnetic iron and nickel, with occasionally other metals, masses of sandstone, mixed masses of metal and sandstone, have all been picked up on the earth after falling from the sky, and have been examined by competent chemists. They are the materials that people space; they are fragments of matter widely, and perhaps universally, distributed; they are materials collected or left behind by the wild comets in their course; they may be the food of the sun, the fuel conveyed in some mysterious manner to keep up that vast burning mass that is the source of light and heat, whose rays give life, and of whose atmosphere we are now beginning to learn something from the experiments recently made on light. And these materials accord pretty well with those common on the earth. They afford no new metal or mineral. They are combinations not unknown, if not common, of very familiar ingredients.

That our whole solar system is occupied more or less thickly by particles of matter of the same kind; that these are collected into masses, varying in size from the dust that no microscope can render visible, to the huge planet Jupiter, and the sun itself, compared with which all the known solid bodies of our system are as nothing; that all these parts to our system are mutually dependent, working together and performing some useful purpose; that there are abundant means by which waste can be supplied and a perfect balance constantly preserved;—all this is so perfectly consistent with what we know generally of the course of nature, and the good providence that has ordered all things, that the idea commends itself to our experience and would be accepted at once by most of us. But if it is so, if really this is the explanation of the phenomena of meteors, fire-balls, falling stars and aërolites; if these are but the dust of our system, they yet seem to follow some definite law, not unlike that which governs our own movements round the sun. Crossing as we do the direction of this strange pell-mell of waste material chiefly at certain periods of the year, it would seem that it is a belt having definite boundaries; but as, on the other hand, though it is on special days that the phenomena are chiefly recognized, there are few nights of the year in which there are not some, there must either be many other such belts constantly crossed, or, which is more probable, all space is thus partially occupied, although there are certain limited and definite groups revolving in an orbit round the central mass of the sun.

But finally, if our own solar system is thus made up, why should not others be so? Why should not whole systems consist of matter less collected into large globes, and more spread in fragments; and why should not some or all of them be self luminous? Such a state of matter might well produce the anomalous appearances presented by unresolved nebulæ, and they would even accord pretty well with the most recent observations on many groups of what has already been called star-dust. It may be wild and fanciful to dream of possible explanations; but where, as in these celestial phenomena, the actual facts are so few, who can help speculating from even the least proved analogies, if they seem to afford a rational clue?

There is no department of science more fascinating than the discussion of these physical problems. But they must not induce us to believe that astronomy can be studied by thus revelling in fanciful dreams of celestial possibilities. They are not without interest, but this is not to be estimated at more than its real value.

THE USE OF LOW POWERS WITH DEEP EYE-PIECES.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

If I may judge from the practice of those microscopists with whom I am personally acquainted, and from the best works on the subject of microscopic manipulation, it would appear that sufficient attention has not been paid to the circumstances under which magnification is best obtained by the employment of low objectives and deep eye-pieces; nor has the power of eye-pieces been as yet brought up to the highest point of practical usefulness by microscope-makers.

In the *Micrographic Dictionary* all that I notice upon eye-pieces occurs in the introduction, at the bottom of p. xvii. (second edition), and runs as follows:—"Always one, and sometimes two eye-pieces are obtained with the microscope; but the highest eye-piece which is made should always be procured, for although high eye-pieces are so far objectionable that they magnify the imperfections formed by the object-glass as well as the image itself, yet they frequently render parts of structure distinct which are perhaps only just perceptible with a lower eye-piece." This passage shows that the able authors of the *Micrographic Dictionary* merely regarded an increase in the power of the eye-piece as a substitute, of a make-shift kind, for an augmentation in the power of the objective. In the valuable lectures of Mr. Lionel Beale, entitled, *How to Work with the Microscope,* the eye-piece question is only glanced at, and in the last edition of Dr. Carpenter's *Microscope and its Revelations,* which is universally regarded as the best authority on the practical use of the instrument, we are told that the utility of deep eye-pieces will mainly depend upon the excellence of the objectives, and that the best objectives, by permitting the use of deep eye-pieces, with little loss of light or definition, afford us a clear gain in range of power, if compared with inferior productions that will only work with low eye-pieces, through not being able to stand the magnification of their defects.

These remarks are true and valuable; but, like those in the *Micrographic Dictionary,* they omit the consideration of the advantages which low objectives and deep eye-pieces have, for certain inquiries, over higher objectives and eye-pieces of less power, and it is to this point that I wish to draw the attention of your numerous microscopic readers.

Every one knows that the penetration of low object-glasses

is greater than that of high ones, using the word in the sense judiciously assigned to it by Dr. Carpenter, who tells us that "the penetrating power of an object-glass (good definition being, of course, presupposed) mainly depends upon the degree of distinctness with which parts of the object that are a little out of focus can be discerned; this," he adds, "will be found to vary greatly in different objectives, being within certain limits in an inverse proportion to the extent of the angle of aperture. . . . . Hence, an objective of comparatively limited aperture may enable the observer to gain a view of the *whole* of an object, the several parts of whose structure lie at different distances from it, sufficiently good to afford an adequate idea of the relation of those parts to each other; whilst if the same object be looked at with an objective of very wide angle of aperture, which only enables what is precisely in focus to be seen at all, each part can only be separately discerned, and the mutual relations of the whole cannot be brought into view."

This passage plainly indicates the advantage of using glasses with moderate angles of aperture when much penetrating power is required; but the principle upon which the advice is given may be extended to a very wide range, if very low objectives, which necessarily have small angles of aperture, are made to give the needful magnification in combination with deep eye-pieces adapted to that end.

Microscopic pursuits always require sound definition, and that being presupposed, we shall find that, according to their nature, they demand penetrating power and resolving power in very different degrees. Were it possible to combine both in the highest degree, the most perfect glass would be obtained; but in point of fact the two stand in such relation that if either is wanted in excess, the other must give way. The student of diatoms, very curious in the minute and closely-approximated markings which ornament the surface of certain valves, is content to surrender penetration in exchange for the enormous resolving power afforded by certain large-angled objectives of Powell and Lealand, or Ross. But there is a class of inquiries that stands at the very antipodes of these researches, and in which very little resolving power is needed, provided considerable magnification can be obtained, accompanied by so much penetration that uneven objects can have all their parts exhibited at one view. When this is required—whether it has been with or without reflexion upon the optical principles involved—most microscopists have no doubt preferred using an inch object-glass with a second or third eye-piece, to a half-inch with a lower one; but the most striking advantage of this description may be obtained with a *three-inch objective* worked up to

any power that may be needed, between 15 to 200 linear, or even more.

The practical direction should be—when you must have considerable *resolving* power, use a proportionately deep object-glass; when you must have great *penetrating* power, use a low one, and gain your enlargement by the eye-piece, if the object be small. Much more penetrating power is lost in doubling or trebling a given magnification by having recourse to an objective of larger angle of aperture and shorter focal length, than by resorting to an eye-piece of the required strength. The mouth apparatus of moderate sized insects, the cells and appendages of zoophytes and similar objects, in which various parts are in different planes, may be well shown with a three-inch object-glass, and the first, second, or third eye-piece of Smith and Beck's series, when half the parts would be out of focus if a two-thirds object-glass were employed to give the same power. I have, for example, a slide containing that exquisite little snailshell, the *Helix pulchella*, which shows beautifully as an opaque object with about forty-five linear enlargement. Gain this with an inch objective, and part is out of focus; gain it with a three-inch, and all is taken in. Here again are some Foraminifera, *Orbiculina*, *Globigerina*, etc., and their ins and outs can be displayed better with the three-inch worked up with draw-tube or eye-piece than by any other means.

The eye-pieces supplied by different makers vary in power. Smith and Beck put three down in their catalogue: the first nearly agreeing with that of other celebrated makers; the second adding three-quarters to the power of the first, making 60, for example, into 105; and the third trebling the power of the first. Much higher eye-pieces upon the Huyghenian plan are of restricted use, on account of loss of light and limitation of field; but Ross,* Powell and Lealand (and Smith and Beck, if required) supply eye-pieces which give about five times the power of the A, or No. 1. By such means a three-inch objective, giving 15,† with my first eye-piece, may be raised to 75 with comparatively little loss of penetration, and good performance upon any object that will bear the loss of light and limitation of field. It would however be desirable to substitute for the fifth Huyghenian eye-piece an achromatic one like Horne and Thornthwaite's aplanatic, or a better combination if it could be devised; but if the principle of

* Mr. Ross has lately made an F eye-piece, giving about eight times the power of the A.

† The three-inch employed was by Baker, and estimated to give a power of 17, with his first eye-piece, which is, I believe, somewhat higher than the corresponding power of other makers.

pushing the power of a low objective be carried much beyond five times the result of the first eye-piece, a totally different construction must be resorted to, or the field will be inconveniently restricted and the light too weak. What may be the best possible form I leave to those specially skilled in optics, and to our great microscope makers; but there is an admirable telescope eye-piece made by Steinheil, of Munich, which works well with a three-inch at ten times the power of the first microscope eye-piece, or at much more if the draw-tube be employed. With this eye-piece and my three-inch I obtain highly advantageous views of small irregular zoophyte cells, and of some of the larger diatoms, whose parts, like those of the *Campylodiscus spiralis*, lie in such different planes as not to come into focus at once if half-inch or higher objectives are employed. Some of the uneven circular diatoms exhibit their concavities and convexities in a surprising manner by this treatment and dark ground illumination. Of course there is a sacrifice of the minute details that cannot be seen without a higher angle of aperture, which must be resorted to for that purpose; but the gain, and a very important one for special inquiries, is in the *penetration*, which is sufficient to bring all parts into simultaneous view.

The eye-piece used in these experiments was sent to me by Steinheil as being the best—indeed the only one, he said, would be satisfactory as regarded light and field—to obtain a power of 300 with an excellent 42-inch telescope, having a three-inch object glass (made by him) upon Gauss's plan. Used as a microscope eye-piece it is nearly as light as a much lower Huyghenian one, and with the three-inch objective takes in a field one-twentieth of an inch in diameter, with a magnification of 150. A power of 130 obtained with a two-thirds, second eye-piece, and two and-a-half inches of draw-tube, had the same field. It is called in Steinheil's catalogue *Mikroskop als Ocular*, and is an erecting combination composed of three plano-convex lenses and a compound front lens. I have used it in extreme ways—with the three-inch power, and with Smith and Beck's one-twentieth, when the enlargement is enormous, and might be advantageous for special inquiries. It is however with very low objectives that I think very high eye-pieces may be most usefully employed, and if the attention of microscopists is directed to the question many objects will become visible *as wholes*, which have hitherto only been looked at in a piecemeal way.

Small crystals, like those of arsenic, which have polyhedral figures, cannot be well shown if such a power as 150 to 200 be obtained in the usual way. If you focus the tops of the pyramids, the bottoms are out of sight, and *vice versa;* but all

comes in at once with the three-inch and the *Mikroskop als Ocular*.

Many persons have Huyghenian telescope eye-pieces higher than those supplied with microscopes, and they will do very well for experiments. If not too high they will succeed; and if they are too high, they will serve to show when another optical combination must be resorted to in order to afford enough light and a sufficient field.

Although the preceding remarks relate chiefly to the employment of so low an objective as a three-inch, the principle upon which they are founded indicates when a two-thirds may be made to do better than one-fourth, or one-fourth than one-eighth.

THE PHASCUMS, OR EARTH MOSSES.

BY M. G. CAMPBELL.

Have any of our readers observed on moist shady banks or fallows, or recently-turned earth, a kind of greenish hue, hardly more to the naked eye than a verdant mildew? When next seen, let them possess themselves of a small bit, by sliding the point of a penknife under a little tuft of it. The plant is far too delicate for the touch of human fingers.

We will suppose this done, and that the tuft is placed under the microscope at the true focal distance from the object-glass. What a forest is revealed by that magic instrument! True, the trees are, many of them, all but stemless, and their modest fruit hides amid the foliage; but how exquisite is that foliage, especially if taken fresh from a damp spot, or if suffered to imbibe a drop of water, which, filling the cells, will expand the leaf to its full proportions.

These plants are of rapid growth and brief duration. Several of them may be found in autumn, and also in spring; some in winter. Wilson has enumerated and described eighteen distinct species of earth-moss, exclusive of the Archidium, or clay-moss, which is an allied species. They are chiefly annuals, with a capsule, very shortly pedicellate, and a calyptra falling away entire, while the capsule is without a deciduous lid, and when mature bursts irregularly to give exit to the small spores, the provision for a future generation of Phascums. These spores the earth receives and garners till congenial circumstances wake up the germ of vitality that slumbers within them, when they shoot forth their little thread-like thalli by hundreds, attain the dignity of perfect plants and of parents, and then

die, leaving the earth a heritage for their progeny, and somewhat the richer for their having lived upon it.

Growing on rather a sandy soil we have the *Phascum serratum.* Its generic name is taken from *φύσκιον*, a bladder, in allusion to the bladder-like capsule of the genus, and its distinctive appellation *serratum*, from the serrated leaves, their edges being toothed like a saw. But what are these branching threads rising up between the leaves, looking like another kind of moss intertwined with it? Not so; they are the young conferva-like shoots of the plant itself, not yet developed into maturity. In the first stage of vegetation all mosses have analogous shoots, but they are more conspicuous in this and its allies than in most other genera, and in *P. serratum* might at first sight easily be mistaken for an intruder. It was, doubtless, these confervoid shoots which caused Dickson and Smith to give this species the name of *Phascum stoloniferum*—a stolon being a long horizontal shoot from the base of a stem: though Wilson seems to think that *P. stoloniferum* of Dickson is a peculiar state of this species, "without the confervoid shoots growing in a scattered manner, with larger, narrower, and more evidently toothed leaves, and with creeping stolons."

The serrated leaves are nerveless, lanceolate, and connivent, *i. e.*, all tending to a central point, embracing the capsule, which is roundish-ovate, and sub-sessile, large in proportion to the plant, of a bright, reddish brown, and somewhat pointed.

Authors differ on the subject of the inflorescence, but in all the specimens we have examined we have found it monoicous, the barren or male flower gemmiform or bud-like, and situated at, or near, the base of the fertile flower; the antheridia are few, and without those succulent-jointed, hair-like bodies often found growing mixed with the antheridia and archegonia, and called *paraphyses:* but, as if to make up for the shortness of the term of their existence, the spores are numerous. We cannot say that we have counted them, but Wilson says they are about 200, yellowish, rough, and globular, as in most of the species.

As we have already said, the Phascums are without a deciduous lid, the seed-vessel therefore remains closed at the top; but when the spores are ripe they burst through the fostering walls that have thus far nourished and protected them, and launch out into the wide world, leaving a fracture on the side of the capsule, which presents the appearance of a chasm, not unlike a miniature crater on the side of an extinct volcano.

In the magnified figure given of the ruptured capsule, one leaf seems blown aside by the spores in their forcible passage out, and this was precisely the appearance under a high magnifying power.

The Phascums are among the most minute of mosses. Our illustration of *P. serratum* shows it in an advanced stage of maturity, and very greatly magnified, the confervoid shoot developed into a long, irregularly-toothed leaf. The network of the leaf appearing only like alternate lines, light and dark, a little higher magnifying power, or a little more light thrown on a single, separated leaf, would show the beautiful reticulation. The species is not unfrequent upon sandy shaded banks, though Hooker says of the whole tribe of Phascums, that they are more frequently met with in the southern, than in the northern parts of Great Britain.

PHASCUM SERRATUM,
Shewing the Capsule burst for the emission of Spores. Very highly magnified.

Another and still more common species is *P. muticum,* or common dwarf earth-moss, found on moist banks and fallows, and fruiting at the same season as *P. serratum,* viz., in autumn and spring. The leaves in this species are widely ovate-acuminate, nerved, very concave, so as sometimes to appear almost hemispherical, the two innermost larger than the rest, erect, minutely toothed above, and all connivent, embracing the immersed fruit, a tuft of this moss looking like a cluster of minute bulbs.

When mature, this species is without the converva-like shoots so conspicuous in *P. serratum.* The capsule is round,

of a reddish colour, thick texture, and is seated on a short, thick pedicel; the columella distinct; calyptra very small, erect, campanulate, covering only the apex of the capsule; spores small, smooth, and round. Barren flower gemmiform at the base of the fertile; antheridia without paraphyses.

Phascum Floerkeanum, or Floerke's dwarf earth-moss, also fruits in September and November. It grows upon clayey or chalky soil, but is less readily discovered than its allies, not merely from its minuteness, being only about one-twentieth of an inch in height, but also from the absence of greenness, its colour being brownish, and scarcely different from that of the soil on which it grows. It is found in scattered patches, has scarcely any stem, and few, but crowded leaves, the lower ones very small and nerveless, the upper ones larger, with an excurrent nerve, concave, slightly recurved at the point, and with a reflexed margin. The areolæ small and rhomboid.

The capsule, which is entirely covered by the leaves, is of a reddish-brown, roundish-ovate in shape, with a thick blunt beak or point, one-third of its own length, and seated on a very short, thick pedicel. The calyptra is sub-conical, sometimes, but not often, cloven on one side. The barren flower is axillary, and the antheridia naked; the spores small, pale, and numerous.

Most beautiful is the foliage of *P. cohærens*, fruiting in the winter, and also bearing an immersed sub-sessile capsule. The leaves are erect, carinate, ovate-lanceolate, usually nerved to the apex; but sometimes the nerve is wanting, or incomplete: the areolæ of the leaf, however, as seen through the microscope, present the appearance of a symmetrical network, and all the upper part of the leaf is serrated.

Among the larger members of the family are *P. alternifolium* and *P. multicapsulare*, both somewhat rare, or overlooked, and both fruiting in the spring.

Other members of the family have exserted capsules, as *P. rectum*, *P. bryoides*, *P. nitidum*, and *P. curvicollum*. Of these, *P. rectum*, or the Straight-necked earth-moss, bears its fruit in winter, and on a straight elongated pedicel. *P. curvicollum*, or the Swan-necked earth-moss, has an exserted cernuous* capsule on a *curved* elongated pedicel. *P. nitidum*, or Delicate earth-moss, grows on moist banks, or on the dried sediment of shallow pools; the height of its stem one to six lines, erect, simple or branched, with new growths, like supplementary extensions of the stem, immediately below the fertile flower, each of these extensions bearing another fertile flower, and in time another, so that sometimes several capsules in different stages may be found at intervals along the stem, giving it the appearance of being pleurocarpous, or lateral

* Bending forward; from *cerneo*, to stoop with the face forward.

fruited, though the fruit is really terminal. The capsule is of a pale brown, of fragile texture, elliptical, with a short, oblique point. Inflorescence monoicous; fruit, autumn and spring.

DISEASE GENERATED BY INFUSORIA.

M. Davaine communicated, a short while since, to the French Academy, a paper on the discovery of infusoria, belonging to the genus *Bacterium*, in the blood of animals afflicted with a disease of the spleen (*sang de rate*). Following this, came another paper by M. Signol, to the effect that these infusoria had been noticed by Fuchs in 1848, and also by M. Brauell of Dorpat, and by M. Pollender. He likewise stated that they had been described by M. Delafond, in the *Bulletin des Séances de la Société des Veterinaires*, in 1860. M. Signol affirms that they appear in horses suffering from typhoid disorders, influenza, etc.; and he adduces a case of their appearance in the blood of a horse that died of gangrene which supervened upon a wound from a pair of scissors. He sums up his conclusions as follows:—

(1) "That bacteriums are not peculiar to the blood of animals suffering from spleen disease (*sang de rate*). (2) That blood containing them will inoculate and give rise to abundance of the same creatures in the blood of other animals so treated. (3) That the presence of fat in the tissues and fluids of the economy, the obese state of the afflicted creatures, the resemblance noted by M. Davaine between these bacteriums and those occurring in butyric fermentation, establishes a presumption that fat plays an important part in these phenomenon."

M. Davaine resumed the subject in a second communication,* which contains the following remarks:—

"In fourteen inoculations of rabbits made with fresh blood infected with bacteriums, similar organisms were reproduced and death supervened. In many cases the infusoria were observed two, four, and five hours before the death of the inoculated animal. In several of these cases blood taken from the animals while still alive transmitted the malady and determined its death with bacterium infection.

"The bacteriums are developed in the blood, and not in any special organ. When by persevering search any of these bodies are discovered at the beginning of the infection, they

* See "Pasteur on Putrefaction," Intellectual Observer, Sept. 1863. *Comptes Rendus*, 10th August, 1863.

are very short as well as very scarce, but they will soon be seen to multiply and grow rapidly, their complete evolution only requiring a few hours for its accomplishment. A rabbit, the blood of which merely exhibited a few bacteriums, from four to six thousandths of a millimeter in length, died at the end of four hours, and its blood, which was examined immediately afterwards, contained a considerable number of bacteriums, some of which, larger than any I had previously seen, reached the five-hundredth of a millimeter in length.

"In some animals the bacteriums are generally found larger than in others, but not presenting any other difference. In such cases their number was usually less. The length which the filaments sometimes acquired suggests their classification among the Confervæ; but I omit, for the moment, the discussion of this question, as it has little importance in the present inquiry.

"The number of the bacteriums varies much between one animal and another. After my first inoculations this number decreased very rapidly, and they became eight or ten times less than the blood corpuscles. This led me to believe that their propagating power dwindled in rabbits, but I was afterwards convinced that such was not the case, as in a series of eleven individuals, one inoculating the other in succession, the blood of the tenth contained myriads of bacteriums like that of the first. I can only explain these variations by the changes in atmospheric temperature which occurred during my experiments.

"When the infected animal dies the bacteriums cease to multiply or grow, and in blood removed from its vessels they become destroyed or transformed. The loss of their primitive aspect is accompanied by loss of the power of propagating themselves in a living animal. Two inoculations effected, one with sheep's blood kept for eight days, the other with rabbit's blood kept six days, neither occasioned the spleen disease nor the formation of bacteriums.

"When fresh blood is rapidly dried in free air, the bacteriums preserve the faculty of inoculation, as I found in many experiments. The dried blood can sustain a temperature of 95° to 100° (C.) without this faculty being destroyed.

"Some fresh blood was enclosed in a tube and kept for ten minutes in water in ebullition. This blood being afterwards introduced under the skin of a rabbit, led to its decease, with formation of bacteriums in thirty-one hours. Cooking is therefore insufficient to destroy their vitality.

"In fourteen rabbits the mean duration of life after inoculation was forty hours; the shortest period being twenty-eight hours, and the longest sixty-seven. The duration was longer

in adults and old animals than in young ones. During this period the bacteriums are slow to appear, but from the moment of their occurrence the animal has but a short time to live. The longest interval that I have observed between the appearance of the bacteriums and the death of the inoculated animals was five hours, thus the mean length of the incubation period is thirty-five hours.

"During the incubation period the animal loses nothing in power or agility; it is only in the last two hours, when the bacteriums exist in notable quantity, that the rabbit ceases to eat or to run. It then lies on its belly, grows rapidly weak, and dies without any special symptom. Sometimes, however, death is preceded by slight convulsive movements."

M. Davaine goes on to say that autopsy shows a healthy condition of the large organs, but the heart and large vessels are distended by very cohesive clots. Coagulation of the blood is thus the only apparent cause of death. During life the microscope shows this coagulative action, as the increase of the bacterium is found to be associated with a viscosity of the red globules, and a tendency for them to adhere together. The large organs only contain the bacteriums as a consequence of their vascularity, and the spleen, which is very vascular, appears the focus of their reproduction.

M. Davaine concludes this paper by observing that experience shows the appearance of bacteriums in the blood precedes the phenomena of disease, and it is therefore natural to refer the latter to the former, which enjoy an individual vitality, and propagate themselves after the manner of living beings. While the blood only contains them in the germ; while their development is not effectuated, the morbid phenomena are not produced. But if the question is examined from another point of view, it seems probable that blood in which they have not made their appearance would be incapable of propagating them in a new animal, that is to say, that during the period of incubation they could not be sown, and the spleen disease (*sang de rate*) could not be communicated by inoculation.

In a third paper M. Davaine states that he inoculated a healthy and vigorous rabbit with three or four drops of blood from another rabbit infested with bacteriums, but still living. Forty-six hours after the inoculation, being six hours beyond the mean time of death, he examined the inoculated rabbit without finding any bacteriums. He then took from its ear twelve to fifteen drops of blood, that were injected into the subcutaneous tissue of a third rabbit, about two-and-a-half months old. Nine hours after this the rabbit first inoculated was found to contain a quantity of bacteriums, and some blood from its ear was introduced into the sub-cutaneous tissue of a fourth

rabbit. One hour after this last inoculation the rabbit first operated on died, and twenty hours afterwards the rabbit last inoculated died; but the rabbit that was inoculated with the blood in which the bacteriums had not made their appearance remained quite well. M. Davaine considers that no one can doubt the connection between the bacteriums and the disease, and he says "by their presence and by their rapid multiplication in the blood, they give rise, after the manner of ferments, to modifications in the blood, which speedily cause the decease of the infected animal."

M. Pasteur has shown that different kinds of fermentation and putrefaction are acts correlative with the lives of organisms of analogous character, and it seems probable that the laws of dialysis, investigated by Mr. Graham, are intimately connected with the chemical influence exerted by these creatures upon the fluids in which they grow.

M. PISSIS ON THE ANDES.

M. Pissis, who has long resided in South America, has presented several memoirs to the French Academy on the geology of that country. These papers, having been considered by a commission composed of M.M. Elie de Beaumont, Boussingault, Danbrée, and St. Claire Deville, form the subject of a report which will be found in *Comptes Rendus* for 6th July, 1863, from which the following particulars are taken:—

M. Pissis occupied part of his time in determination of mountain heights, among others those of the elevated peaks surrounding lake Titicaca. The report states, "the altitudes ascribed by him to Illimani and to Nevado de Sorata agree with those deduced from the measurements of Mr. Pentland, made during his second voyage to Bolivia, and with which M. Pissis could not have been acquainted. This fortunate agreement between two able observers leaves no doubt that Chimborazo exceeds by some hundred meters the two colossal mountains of Upper Peru.

"It was also reserved for M. Pissis to determine by a complete geodesic operation the height of Aconcagua, the most elevated of the yet known peaks of South America. Measured by means of two different bases, Aconcagua appears to have an altitude of 6834 meters, and thus to exceed Chimborazo by about 300 meters." In a note the commission refer to Mr. Pentland's estimation of 7300 meters for this mountain, which they say differs little from that of Captains Beechey and Fitzroy. They proceed to quote the words of M. Pissis, who observes

that, "in a geological point of view, this mountain, ordinarily spoken of as the volcano of Aconcagua, is in réality not volcanic. It is composed," according to M. Pissis, "from its base to its summit of stratified rocks, the lowest of which is composed of those same porphyries met with at every step on the Andes; while those on the summit, as judged of from some detached blocks, appear to belong to the cretacean system. It occupies the middle of a great circle situated a little to the east of the line of the Andes, from which it is separated by the valley in which the Rio de Mendoza has its birth. Some syenitic rocks show themselves in the lower part of this circle, which, at the time of my visit, was almost entirely filled with snow, which prevented my satisfying myself whether it contained eruptive rocks of more recent origin."

The commission remark that, "in spite of the just reserve of M. Pissis, it is difficult to avoid the conclusion that the peak of Aconcagua occupies the bottom of a vast crater of elevation," a conclusion with which few English geologists would concur. Aconcagua is far from being isolated, as M. Pissis mentions three other peaks in its neighbourhood, reaching elevations of 6799, 6527, and 6347 meters. "Everything indicates that on that spot the most elevated mountain masses of the American Continent are found."

A study of the movements by which its present relief was imparted to the South American Continent has led M. Pissis to assert that its stratifications present *nine* general divisions:—

"1. THE CHILIAN SYSTEM, *i.e.*, the most modern of all, and posterior to the marine sands Atacama (remarkable for their deposits of nitrates) and to the formations of transport (*terrains de transport*) of la Paz.

"2. THE SYSTEM OF THE PRINCIPAL CHAIN OF THE ANDES OF CHILI, posterior to the lacustrine and marine deposits of Bolivia, of Chili, and of Patagonia, having a direction exactly N. and S., with appearance of trachytes and argentiferous seams.

"3. THE SYSTEM OF THE TRANSVERSE CHAINS OF CHILI, posterior to the calcareous and saline marls, having a direction approximately E. and W.: Labrador rocks and cupriferous beds.

"4. THE WESTERN CHAIN OF CHILI SYSTEM, anterior to the saliferous marls, posterior to the '*grès rouges*:' direction sensibly the same as in the first system: syenitic rocks, auriferous pyrites.

"5. THE EASTERN CHAIN OF CHILI SYSTEM, the elevation of which, contemporaneous with the eruption of quartziferous porphyries, occurred during the Jurassic period.

"6. THE SYSTEM OF ITACOLUMI, the appearance of which

was posterior to the carboniferous lime, and anterior to the *grès rouges* of South America.

"7, 8, 9. ELEVATIONS OF SCHIST ROCKS OF SOUTH AMERICA, of which M. Pissis distinguishes three kinds, all very old."

M. Pissis considers that each movement of elevation was characterized by the emission of a particular rock, which takes the place of a characteristic fossil in the determination of its age.

THE PLANET MARS: A FRAGMENT.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

(*With a Coloured Plate.*)

"I give the first watch of the night
To the red planet Mars."—LONGFELLOW.

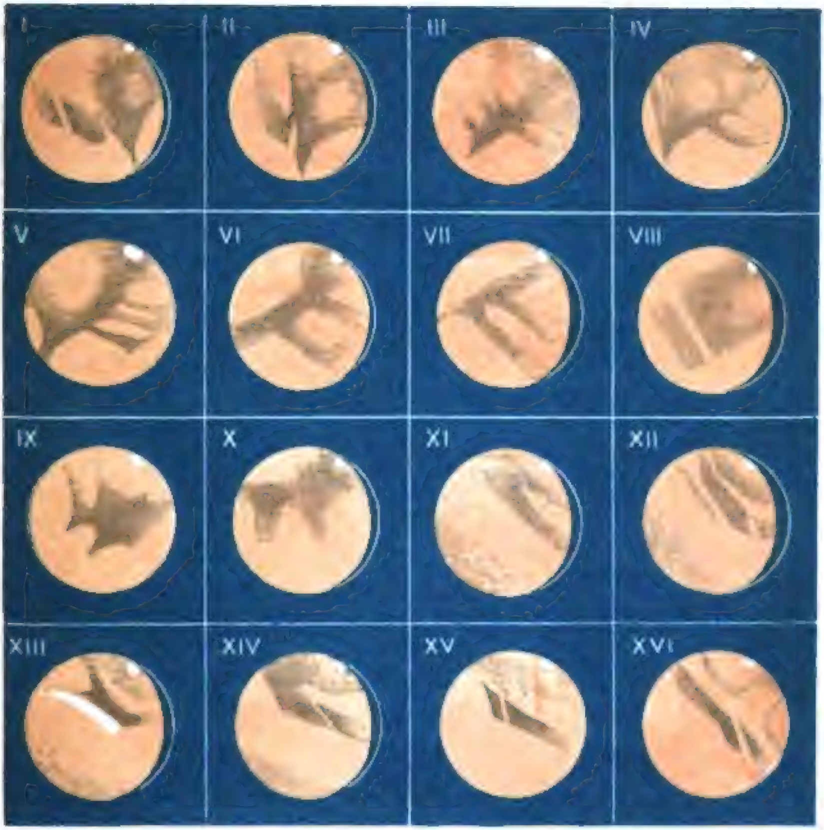
FROM the tenor of some remarks which appeared in the present publication previous to the late opposition of MARS,* the idea may possibly have been entertained that the author of them intended to avail himself of that opportunity to make some detailed observations upon the aspect of this interesting planet. The impression would have been well-founded. I had purposed to undertake a careful examination of the physical features of Mars, as far as they would be brought out by the power of an excellent 5½ inch object-glass, and securing, if possible, a delineation of as much of his surface as would at that time be exposed to view. It was indeed to be expected that the same task would be taken in hand by far superior observers, armed with much more powerful instruments, and, in part, favoured by purer skies; yet it did not seem to follow that a more humble attempt would be superseded, or would necessarily prove entirely useless; for it has not unfrequently been the case that inferior observations have found a place for themselves in that general accumulation of materials from which our final deductions have to be inferred. The peculiarly valuable investigations of Beer and Mädler were long carried on with an object-glass of not more than 4½ inches aperture; and a quotation which they have employed will furnish an appropriate motto for any similar case:—

"Quod potui feci; faciant meliora potentes."

The execution of my design proved indeed far more defective than I had anticipated. Absence from home, cloudy weather, and seasons of bad definition conspired to interpose

* INTELLECTUAL OBSERVER, viii. 132. See also xi. 376.

THE PLANET MARS.



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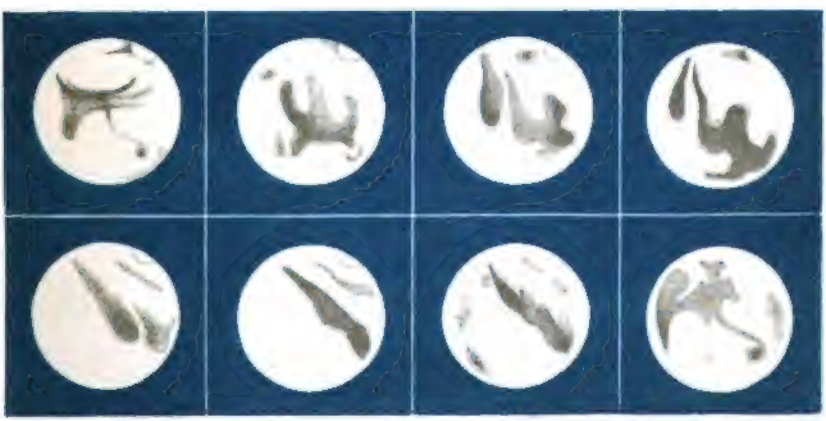

BEER AND MAEDLER 1830 1839.

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obstacles of a grave character, and at length my series of sketches, a great proportion of which were of a rough, imperfect nature, were found to combine into a delineation, of which some parts were especially unsatisfactory. Nevertheless, I have not felt disposed to suppress my results, because I have thought that they may prove interesting to other observers not more successful than myself, and because I believe that, notwithstanding all their shortcomings, they sufficiently establish the two points I had especially in view—the permanency of the principal configurations of the planet, and their occasional obscuration from some transitory cause. For this purpose, however, a reference to former observations would obviously be essential; and here considerable difficulty arose. My original intention was to have given an extended selection from all the previous designs to which I could obtain access, but I was subsequently led to prefer a comparison with the work of Beer and Mädler alone, as a well-known and accredited authority, and fully sufficient for my purpose; and hence I have not availed myself of some obliging offers of assistance from contemporary observers; partial illustration of this nature tending to produce confusion in a somewhat perplexing subject, whose complete elucidation must be given, if at all, from a more comprehensive point of view. Having made choice of Beer and Mädler as my standard of comparison, I thought it right, in order to secure impartiality, to avoid looking at their designs, and indeed almost any others, during the whole course of my observations; and as I had not previously referred to their work for a long time, I was enabled to escape any bias either of the eye or the judgment. However defective my result may appear, it has at any rate been attained by an independent procedure.

A superficial comparison of the published views of Mars would be likely to lead to the idea that, with occasional generic resemblances, such as exist in the case of the belts of Jupiter, the differences are too wide and too irreconcilable to be accounted for on the supposition that we see the permanent features of the planet. But many circumstances would require to be taken into consideration before such a conclusion would be admissible. We have to bear in mind the minuteness of our object: the globe of Mars is but about twice as large as the Moon, and its distance towards forty millions of miles; so that Beer and Mädler found it desirable to employ a power of three hundred to develope its details satisfactorily, and even with this they only unfolded themselves gradually to the eye. A lower power I found indeed adequate, but with an aperture giving me about half as much more light; and when the weather would admit of it, was glad to follow their example. Again,

we have to contend with the peculiar difficulties presented by spherical perspective; difficulties that would hardly be imagined by an inattentive observer. Our eyes are apt to be misled by being accustomed in youth to the common projection of the earth in two hemispheres, till we get to suppose that such would be a real view of our planet at a distance; but this impression is highly erroneous. In such maps, where the half of the globe is attempted to be as it were squeezed flat, the marginal regions are necessarily enlarged, and the central parts reduced, to effect some kind of conventional correspondence, and render the map of any use; and we gain no idea from it how extreme, in nature, is the foreshortening towards the edges of a globe in a perspective view; how small a portion of it is seen in its true dimensions; and how soon, in every direction, the surface rounds off and falls away from the sight. This however, great as it is, is not all the difficulty. Were the position of the axis of the globe invariable with respect to the observer, though much of the surface towards the poles would be very ill seen, the perspective of what is seen would be constant, and readily intelligible, as we notice in the case of Jupiter, whose polar regions are foreshortened to obscurity, but whose equator lies always alike straight before the eye. But where, as in Mars, the axis is at different epochs very differently presented to our sight, though more of the surface is in the end rendered visible, yet the effect of perspective is much more complicated, and the apparent changes of form resulting from it much more perplexing. All this may be readily illustrated by means of a terrestrial globe viewed from a fixed position. If, in the first instance, its axis is placed vertically, the effect of rotation will be a wide difference in the apparent form of the continents as they occupy the edges or pass across the centre, and we shall be convinced how very unlike must be the hemisphere of the map-makers to that beheld by a distant external eye: these changes however will be regularly recurrent; all the parallels of latitude will continue sensibly straight; and the central aspect will be successively always the same. But if we now incline the axis about 23½°, and place it in various directions towards the eye, so that at one time both poles shall be in the limb, at others each in turn shall be more or less advanced towards the spectator, the surface will be presented in aspects continually varying; the parallels of latitude will be at one time straight, at others projected as semi-ellipses, with a curvature turned sometimes one way, sometimes the other, according to the position of the axis; even the central representations will be quite unlike at different times, though the same side, in a general sense, may be opposite to us; and the effect of rotation will be a change, in

every case, of perspective foreshortening and apparent direction of motion; so that a succession of views of the Earth, as obtained in different positions from the Moon or Venus, would exhibit a strange degree of dissimilarity, and much difficulty at first in identification. All this holds true with regard to our views of Mars, and even more, from the greater inclination of his axis, amounting to about $28\frac{3}{4}°$:* and here we find the principal source of the obvious and, at first sight, almost irreconcilable differences in the existing views. To this we must also add other casual sources of deception, such as the misleading of the eye, by the oblique passage of the axis through the field of the telescope, where there is no clockwork motion; by the effect of phasis, not always duly allowed for, especially when a ready-prepared circle is used for delineation; and by the fact that the defalcation does not necessarily begin at the white polar spot, but at, or not far from, the apparent vertex. Some of these causes of error, I have had subsequent reason to think, have affected my own sketches, and possibly may have influenced those of other observers. All this considered, we shall cease to wonder at the striking dissimilarity in the representations of Mars taken at different epochs; and when we have added the equivalent of what astronomers call "personal equation"—the strangely varying judgment formed by different eyes, and occasionally by the same eye under different circumstances—as well as the inadequacy of many hands in delineation, we shall see reason why even views of the same opposition, taken by different observers, are often more unlike than might have been expected.

With respect to the drawings accompanying this paper some explanation is requisite. They are the best out of a set of forty-three, extending from September 16 to December 20, 1862; and, being intended to exhibit every portion of the globe then visible in succession, with some repetitions for the illustration of details, they stand in the order of *rotation* and not of *time*. The apparent irregularity which will be remarked in the position and magnitude of the phasis arises from this cause; its real value having been carefully attended to in each instance.† Equality of size has been adopted for convenience, but in fact the diminution of the disc towards the close, December 20 giving only $10''\cdot4$ against $21''\cdot8$ on September 26, was such as

* This quantity is subject occasionally to a slight apparent increase, arising from the inclination of the orbit of Mars to our own, which amounts, according to Lindenau's Tables, as cited by Arago, to 1° 51′ 6″·2. This value differs somewhat from that given by Sir William Herschel, who makes the inclination of the axis of Mars to our ecliptic 30° 18′, and to the plane of his orbit 28° 42′.

† The same singular and unexplained anomaly of phasis is said by Mädler to occur in Mars as in Venus (see INT. OBS. xviii. 455), *the observed always falling short of the computed magnitude.*

to render the later observations much more difficult and precarious. The position of the axis, as indicated by the snow-spot, is represented as inclined about 30° to the meridian; but this was a mere rough estimate, no measurement having been attempted. The more luminous part of the disc had rather a yellow than a red cast in the telescope: the darker spots were grey, slightly tinged with blue, or perhaps greenish blue. Only two of the sketches here engraved (Figs. IV. and V.) were coloured at the time, the others being not considered worth the trouble; but they have been all tinted in the plate for the sake of uniformity. The reader, however, is requested to lay no great stress upon details, as, from imperfect definition, or the planet's increased distance, many of them are of the roughest character, and no attempt has been made to retouch or harmonize them. Fig. V. is probably the best, having been compiled from three separate sketches on the same night with a power of 170: there was "so much fog as probably to diminish the planet's light by $\frac{1}{3}$rd or $\frac{1}{4}$th, but very nice definition, and the disc just like a distant globe." Such remarks were rare indeed. The observing power was usually 170, quite high enough for the ordinary state of the air in an unfavourable season; but on some occasions 275, 300, and even 460, were used with advantage. I repeatedly caught momentary glimpses of very curious detail in the dusky markings, which were immediately snatched away by the fluctuation of the atmosphere; and on one occasion especially (November 10), the unsteadiness of my stand in a violent wind deprived me of many interesting particulars of this nature which seemed otherwise accessible.

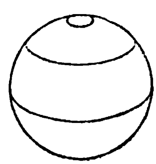
The following were the approximate dates of the selected drawings, and the circumstances of the observations:—No. I. Nov. 10d. 10h.—II. 10h. 40m.; steady but rather woolly definition, with very baffling and annoying wind; in best glimpses the tone of the dark portions was very dappled and uneven; the spot C* was evidently full of detail. The left side of the fan towards the centre of the disc was darkened in a line with the bright division beneath it, the continuation of which was to-night very difficult to be perceived, though in other sketches it is carried through boldly.—III. Sept. 29d. (hour in error); inferior definition and time limited.—IV. Nov. 5d. 10h. 15m; good definition, with an unpleasant flare and uncertain focus.—V. Sept. 26d. (hour in error); great distinctness in foggy air.—VI. Nov. 4d. 11h. 5m; markings feeble, especially considering the sharpness of the limb.—VII. Dec. 10d. 9h. 30m.; disc sharp even with 460.—VIII. Dec. 8d. 10h. 30m.; very faint, and stand unsteady in high wind.—IX. Sept. 19d. 10h. 45m.; pretty good defi-

* See Diagram, *postea*.

nition.*—X. Nov. 26d. 6h. 30m.; very faint and uncertain. —XI. Nov. 24d. 9h; "Painfully woolly, though the limb is clear."—XII. Nov. 24d. 10h. 10m.; somewhat darker and more decided.—XIII. Nov. 22d. 9h. 20m.; definition very fine; limb and polar spot very sharp, but spots ill marked and feeble. The planet is growing very small and gibbous.—XIV. Nov. 15d. 7h. 10m.; transparent sky and pretty good definition, but spots faint and confused.—XV. Oct. 9d. 8h. 5m.; sharp definition, but unequal to fine details.—XVI. Oct. 8d. 10h. 20m.; the same conditions; N. edge of long spot very hard and strong across the centre; spots further S. very faint and ill defined.

It fortunately happened that the opposition of 1830, so carefully observed by Beer and Mädler, and even that of 1832, were combined with a presentation of the axis sufficiently similar to admit of a very fair collation with that of 1862, and consequently eight of their figures, the first six belonging to the former, and the others to the latter epoch, are subjoined at the lower part of the plate, being left untinted to correspond with the originals, but having their axes inclined for the sake of comparison.

The sides, if a globe can be said to have sides, delineated in my Figs. I. to IV. and XIV. to XVI., I consider the best determined; comprising, I am sorry to add, not much more than a hemisphere: the rest is far less satisfactory, depending on fewer drawings, and with a greatly reduced diameter and enfeebled aspect; and of the exact connection between Fig. IX. (or X., which seems to be an imperfect repetition of it, but the only corroboration I have), with VIII. on the one side, and XI. on the other, I am very ignorant: I can only feel assured that there were no great spaces intervening. On the whole, if the distorting effect of rotation performed in oblique spherical perspective, with the axis inclined about 25½° to the spectator, as shown in this diagram, is duly allowed for, with many other hindrances best known to those who have ever made such an attempt, it will be found that this series represents tolerably the chief features of a great part of the S. hemisphere.



The combination of the whole, however, into one polar projection, a mode of representation first attempted by Sir W. Herschel, and subsequently adopted by Beer and Mädler, I

* The night of a splendid meteor, whose path has been calculated by Mr. Herschel. It was nearly vertical in London, but here low in the E., and not far from Mars, so that I should have seen it to advantage had I not just left the telescope. All I could catch was its train descending towards the horizon; but a person who was with me saw it first ascend a short way and turn over in a narrow parabola. The light was very vivid.

found essential to explain and reconcile many of my figures; and as the mode by which I obtained my diagram may possibly be serviceable to some brother amateur who may have been engaged in a similar study, or may be of use at some future opposition, it may be well to describe it. A circle cut out in cardboard, and divided round the edge into twenty-four hours, numbered (like those of Right Ascension) from W. by S. to E., is intended to represent the visible portion of the planet, viewed with the S. pole in the centre. This is capable of being turned on its axis within a somewhat larger circle drawn on another piece of cardboard, and divided by radii from the common centre into sections, three of which coincide with two of the hour-divisions on the moveable circle; each, therefore, corresponds to forty minutes of time; and as, fortunately, the rotation of Mars exceeds that of the earth by very nearly this quantity,* each of the divisions on this outer circle in succession, reckoned the opposite way to the hours on the inner moveable circle, indicates the position of the observer's eye on each successive night as long as the circle lasts, that is, for thirty-six days; but as the whole series of observations much exceeds this period, three other circles are drawn just outside of it, one beyond the other, which carry forward the series of days successively in turn from Sept. 16 to Dec. 20. Any day and hour, when a satisfactory sketch was taken, being then fixed upon as a standard, as for instance, Nov. 6, 8h. 45m., the moveable card representing Mars being so set as to have that hour coinciding with the given day in one of the outer circles, will stand in a right position with respect to any other day in all the four circles, at the same hour: for any earlier or later time of the evening, the corresponding hour-mark on Mars (the moveable card) being brought opposite to the standard day (Nov. 6), the diagrams will be set correctly for that time for every day in the series. Sketches taken at any time may then be transferred to the moveable card, in that peculiar conventional kind of projection which is used in similarly constructed maps; and though the distortion will be very great, identification, the chief object, will be attained. One consideration only interferes with the simplicity and facility of this plan—the orbital movement of the planet during a long series of observations, in consequence of which the position of the apparent centre of the disc will be somewhat altered; but this may be allowed for by constructing a little table, by which a correction may be applied to the hour of observation. Nov. 6 being fixed upon as zero, this correction fortunately proved always subtractive; it amounted to 43m. on Sept. 19, and 37m. on Dec. 20.

* The exact duration of the solar day and night upon Mars is fixed by Beer and Mädler at 24h. 39m. 35·7s.

By this mode of comparison I soon became aware of a greater degree of imperfection in my sketches and uncertainty in the judgment of my eye, than I should have otherwise expected, and I was enabled to clear up several points that might otherwise have caused ambiguity. The result is a very rough approximation, without any claim to correctness in detail; but as it was the fruit of four separate attempts of combination, all agreeing tolerably in essentials, it is given here, partly as the means of reference and of connecting the diagrams, and partly as an entirely independent, however inferior, deduction, for comparison with the similar S. polar projection of Beer and Mädler, of which a reduced copy is added.

BEER AND MÄDLER.

WEBB.

The principle I have usually adopted has been to enter every portion as dark, which was ever so seen, though at other times it may have been luminous, on the ground that, reasoning from analogy, the surface of water, or marshy land as suggested by Beer and Mädler, would be less reflective than the upper illuminated surface of clouds or vapours, and that the dark spots would therefore be probably the more permanent features. It has been already stated that one portion of the hemisphere is much better delineated than the other; this, adopting Beer and Mädler's notation (though they reckoned from a spot which I never clearly made out), lies between long. 30° and 240°; while the configuration from 270° to 30° is especially uncertain, and may be materially wrong.

Although the first impression is not that of much resemblance, with careful attention a considerable similarity may be made out, as to general arrangement, between my figures and planisphere, and those of Beer and Mädler. For instance, the

spot I have marked A, and which usually appeared like a great half-opened fan of darkness, is evidently the same with that in Beer and Mädler, intervening between long. 30° and 90°; the long canal B is easily identified; my C corresponds with their sloping spot between 90° and 120°; D agrees still better, E forming, I believe, the end of their long leech-shaped spot; F may be recognized between their 30° and 90°, in lat. 30° to 60°; and other less certain correspondences may be traced or fancied. On the whole, we may conclude that the general permanency of the dark markings may be considered as satisfactorily established merely from these two sets of observations, even if De la Rue and Jacob's drawings did not, in part, lend their powerful aid. But though this independently-formed inference appears satisfactory, I have the pleasure of knowing that it has also been deduced by Secchi, with the great achromatic at Rome, and by our own countryman, Mr. Lockyer, who bears most honourable testimony to the accuracy of Beer and Mädler.* Whether, therefore, we are correct in supposing that the globe of Mars is occupied by land and water like our own, which is certainly very possible, or whether the difference of aspect is due to materials which only bear a certain analogy to them—for which belief, too, reasons might be adduced—we may consider the fact of a distribution of his surface into two permanent divisions as sufficiently ascertained.

Nevertheless, with this general resemblance there are tokens of special differences far too wide to be comprehended in any fair margin of allowance for terrestrial impediments and difficulties. The weather was usually so unfavourable that I seldom saw as well as the defining power of my instrument would warrant; and other eyes and hands might have otherwise viewed and represented what I did see. Still, mere inspection will make discrepancies evident which must have had their origin beyond our own atmosphere, and which no amount of blundering on the part of any one will serve to explain. Here, then, we seem to find indications, not to be mistaken, of an atmosphere surrounding Mars, charged with vapours as dense and agitated by currents at least as extensive and as rapid as our own.

This—the second point to which my attention had been

* The very beautiful series of drawings by this observer, exhibited at the last meeting of the Royal Astronomical Society, and destined for publication in its Memoirs, while they fully corroborate my own in a general sense, and complete their deficiencies, are much superior in that minuteness of detail into which a 6-inch object-glass would enable him to penetrate further than myself. A novice might perhaps be surprised at this assertion; but half an inch in the diameter of an object-glass is of material importance—the brightness of the image varying directly as the *square* of the linear aperture. Mr. Lockyer's glass possesses therefore one-sixth more light than mine.

directed—appears to be satisfactorily cleared up. Without seeking confirmation from the opinions of Herschel and Schröter, or referring to the obvious deviation from the forms given by Beer and Mädler, the conclusion would naturally follow from my observations alone. The reader may notice several instances of diversity, due probably to this cause; but two may be especially pointed out—the varying aspect of the north or narrow end of the dusky fan, which frequently and unmistakeably appeared pointed, but occasionally more open, especially in Fig. V., on one of the finest nights of definition; and the contrast between Figs. XIV. and XV., from which, as both were careful observations, it is fair to conclude, either that the narrow isthmus* crossing obliquely the dark spot was laterally moveable, or that in the latter instance the west end of the spot (E in the planisphere) was temporarily obscured. Still, were this dependent merely upon my own testimony, I might feel less confident, but Lockyer's most careful observations, corroborated by Dawes, have led him to the same inference; Lassell has found recurring phases so far from uniform as to infer "the transit of clouds of great extent, density, and variety of form;" Groves had come to a similar conclusion; and Phillips, from a comparison of his own drawings with those of the Earl of Rosse and Lockyer, is even led to entertain "serious doubts whether any of our drawings of those" southern "parts are much to be trusted as representing permanent physical boundaries. Nor should this," he adds, "be thought surprising; owing to the high inclination of the axis of Mars to the plane of his orbit, the regions round each pole are presented alternately to the sun through periods somewhat less than our whole year. The effect is seen in the vast outspread of snows round the cold pole, and the contraction of those white sheets to a small glittering ellipse round the warm pole. The enormous transfer of moisture from one hemisphere to the other while the snows are melting round one pole and growing round the other must generate over a great part of the planet heavy storms and great breadths of fluctuating clouds, which would not, as on the quickly rotating mass of Jupiter, gather into equatorial bands, but be more under the influence of prominent land and irregular tracts of ocean."

* This division between D and E does not appear in Beer and Mädler: it may be doubted whether from want of optical power: with me it was a frequently recurring feature, traceable more or less distinctly in six sketches between October 9 and November 24. When Fig. XV. was drawn, I was inclined to believe that a steadier air might have shown another bright but very narrow partition just to the right of it. November 17, when the figure was intermediate between XIV. and XV., a similar impression recurred, and even a surmise of another bright longitudinal streak connecting the two oblique ones; but these additions were extremely uncertain.

The contraction of the snow was very obvious in this series of observations, and will be traced in the drawings if they are examined in the order of *time* and not of *position*. Aug. 14. I had caught it even with a power of 55. Sept. 29. I thought it "much less conspicuous." Oct. 8. It was a "very minute speck." Nov. 4. I estimated it, from memory, at not more than 1''·5. The sharp definition of the disc that night permitted me to see with a power of about 300, what I had seldom been able to satisfy myself about, that the white ellipse was all within the limb, and as I believed not even in contact with it. The following night I noticed that the snow was not more than one-twentieth of the diameter (afterwards found to be 17''·5), and could not exceed 1''. With regard at least to the region of the dusky fan, and the antarctic circle, I think it appears that there was considerable more open sky in Mars in 1862 than in 1830.

Some observers have noticed a luminous border around the limb, and considered it as an indication of a dense atmosphere. This never caught my attention. Nov. 4. "I looked for a luminous ring round the limb, but could see none. The great spot (Fig. VI.) extended close to the limb, if not to absolute contact." Nov. 5 and 6. The markings in general reached the limb, and there was no luminous circumference. Dec. 10. Fig. VII., "The darkness of the end of the band near the pole is decided close to the limb." At other times I have thought that the spots became much less visible near the edges of the disc, as was usually remarked by Beer and Mädler; but it is not always easy to distinguish between perspective foreshortening and atmospheric obscuration.

Nov. 22. A bright border, as in Fig. XIII., was repeatedly suspected to attend the N. edge of the dusky band G., then lying centrally across the disc. It was, however, much less luminous than the snow-spot. It will be observed from the drawings that on this side of the globe there were repeated traces of faint shadowy markings in the N. hemisphere. Nov. 24. Fig. XI. "There seems to be a large amount of minute detail over the N. part of the disc, quite out of my reach: the whole is painfully woolly, though the limb is clear."

Oct. 11. I noticed for the first time a patch of bright green light, occupying an arc of 40° or 50° S. from the equator along the *following* limb, or terminator. I saw it again, more or less, on several occasions in the course of the next month, and probably might have perceived it before, had I more frequently used the higher powers, which almost exclusively rendered it visible. I was prepared for nothing of the kind, and had not thought of Mädler's similar observations in 1841 with the great Dorpat achromatic. It is probably merely an optical deception, but nothing of this kind should pass unnoticed.

In concluding this fragment, let me express a hope that the whole subject of Areography may shortly receive that more satisfactory illustration, of which it is certainly capable, from a diligent and extended collation of ancient and modern delineations. This has never yet been accomplished; and, from the number of observers during the late opposition, it is more practicable than at any former period. Much interest could not fail to attach to a careful monograph of a globe in many respects so closely resembling our own.

DOUBLE STARS.

An interesting communication with which I have been favoured by Dr. Dobie, of Chester, the possessor of a very fine $5\frac{1}{2}$ inch object-glass by Cooke, has enabled me to make a valuable addition to our list of Double Stars. The *pointer* on this occasion is *β Cassiopeæ*, the preceding, or in its present position the uppermost, star in that constellation: the finder will include in the same field with this star a small open pair, lying at a short distance *s p*. Each of these is double. The preceding one is

118. Σ 3057 (which in astronomical notation implies the double star so numbered in W. Struve's Dorpat Catalogue). 3″·64. 299°·53 (1832·29). 7·2 and 9·3 of Σ's scale of 12 magnitudes, which in Smyth's, of 16, would be about $7\frac{3}{4}$ and $10\frac{3}{4}$. Yellowish and ash-colour. Mr. Knott, who has obliged me by a careful examination of these objects, gives measures so closely accordant—3″·732 and 298°·55 (1863·52)—that the object seems merely an optical one. The other pair is more interesting:—

119. Σ 3062. The distance and angle have here rapidly varied, Σ giving 1″·25 and 36°·7, 1823·81; 0″·41 and 132°·62, 1835·66; 0″·49 and 157°·9, 1837·78:—Dawes, 0″·954 and 193°·43, 1841·86:—Mädler, 1″·05 and 220°·73, 1846·53:—Knott, 1″·444 and 265°·59, 1863·52 (the results, however, of a single night, and the distance possibly rather wide). This is, therefore, a binary system with a rapid motion, whose period, according to Mädler, will be completed in 146·83 years. Both stars Σ makes yellow; his magnitudes are 6·8 and 7·9: Knott gives 7·5 and 8.

As these two pairs both lie in the same field, and can both be seen double, with a power of 110 in his instrument, Dr. Dobie justly observes that they form a nice and very easily-found test for moderate-sized telescopes. He could see the whole with an aperture reduced to $3\frac{3}{4}$ inches.

Nearer to *β Cassiopeæ*, in fact the nearest object in the finder *s*, a very little *f*, I have noticed a very curious and beautiful little triangle of 8 mag. stars, suggesting strongly the idea of real juxtaposition in space, and consequent connection.

70 (p) *Ophiuchi* (42 of our list). Krüger, the great investigator of this star, from further observation prefers a parallax of $0''\cdot162$, subject to an uncertainty of $0''\cdot0071$, inferring a mass in the system 3·1 times greater than that of our sun, and a distance which light would traverse in 20·1 years.

OPTICAL DECEPTION.

The evening of July 27, 1863, had been cloudless, but hazy, with flaring and fluttering definition. As night advanced, however, it improved, and towards 11h. the discs of the stars came out finely: about this time, in endeavouring to meet with the beautiful triple star ϵ Equulei (which has no place in our list, from the difficulty of finding it from description), I came across a 6 mag. star with a close 8 or 8½ mag. companion, at about $1''\cdot5$ and 330°, both discs being very nicely defined. Thinking that this might be an object of W. Struve's, which I believed to exist in that quarter, but had never seen, I looked carefully at it, and continued my search, turning to a similar star in the field of the finder, some 2° distant. To my great surprise this had the same appearance. I tried a third; they were all alike. I at once turned the eye-piece (an achromatic combination by Powell and Leland, giving a power of about 300) round its axis; but the images remained unchanged. I then turned the object-glass one-third round; the companion was still there—I fancied at first somewhat altered in angle, but further examination proved that I was mistaken; and a turn of another third made no difference. A star not far from Al Tair gave the same result, perhaps less distinct. I looked to the west towards Hercules; still something of the same kind came before me, though not so clearly. I returned to my first three stars; in each case the attendant was still perceptible, though much less obvious, and apparently fading away: while occupied among them, I came unexpectedly across my intended object, ϵ Equulei; and here the beautiful and black division of the close pair at once satisfied me that neither the eye nor the instrument could be the cause of this singular deception. I regretted that its short continuance, and my own haste, prevented me from testing it more fully on other stars, and with other eye-pieces, but as to what I did see, no doubt remained. During an experience of many years, I cannot remember a similar illusion, excepting, perhaps once, with a single star, and even that may be questionable. It may possibly be referred to some unusual condition of atmosphere, producing, apparently, for a short time, something like double refraction in a vertical plane. Similar

effects, it is well known, are frequently perceptible in looking at distant shores or vessels across a considerable intervening surface of water—a species of *mirage*, of which I was a frequent spectator at Clevedon during the summer of 1846, especially in using a little hand-telescope.

NOTES ON THE HORNED PHEASANT.

BY R. C. BEAVAN,

Lieutenant Bengal Est., Member of Asiatic Society of Bengal.

HAVING, during a two years' residence at Darjeeling, in the Sikkim Himalaya, had many opportunities of observing the habits of *Ceriornis Satyra* (*Satyra melanocephala* of Blyth), I take the liberty of adding a few remarks to the account published in the INTELLECTUAL OBSERVER for September.

I have seen them both in their native wilds and in captivity, in fact have often been after them gun in hand, attended by a single trusty Nepaul shikaree (sportsman). I have generally found them on the steep forest-clad slopes of the mountains, at an elevation of from 6 to 9000 feet above the sea. They generally prefer the neighbourhood of water, but are, as far as my experience goes, always found among the densest underwood, and where the greater part of the vegetation consists of oak, magnolia, ilex, etc., and the other trees of that zone. Seldom seen in trees, except when disturbed by a dog, on hearing a human footstep they invariably run if they can, and it is anything but an easy matter in Sikkim to get a fair shot either at these or any other of the game birds that inhabit that country. When they do rise, they always fly down the side of the mountain, and the momentary glimpse one gets of a scarlet object between the trees, flying very rapidly, is to a man who perhaps for some hours previously has been toiling on hands and knees, and creeping through prickly bushes as silent as possible, under such circumstances anything but satisfactory. Shooting under such difficulties is therefore but little followed up by the Europeans; but those who want skins of birds, or game for the table, generally hire a native, either a Lepcha or a Nepal man, and they, by lying close near the known haunts of the birds, and imitating their call, draw them within shot.

These birds are generally found in pairs. The only time of year that even the natives can get at them is in the winter months, when the underwood is not so dense as at other times. The usual plan of capturing them is by making a low hedge, of about three feet high, of bushes, extending down the side of a hill, like the sides of a triangle with the base open. These

sides gradually converge until near the apex, where small gaps are constructed, each armed with a small noose. The birds are then gradually driven by men on foot—simply walking in line towards the base of operations I may call it—and the birds running on, instead of attempting to fly, run through the openings, and are caught in the nooses.

A curious fact with regard to this mode of capture remains to be noticed. The proportion of males to females are generally four or five of the former to one of the latter.

The birds are then brought into Darjeeling for sale, and fetch about 4s. each if it happens to be a dry season, but generally more. I have seen them sold at 2s. each. Early morning or in the evening are the times to go after them, the former preferred by the natives. They are then heard calling on all sides, and by dint of severe crawling and creeping one has the chance of a shot, which as likely as not will be at the bird running. The sportsman must avail himself of the very first glimpse of the bird to fire, or he will not be likely to see it a second time.

The lowest ranges of these mountains are inhabited from the plains to 3000 feet by the jungle fowl (*Gallus ferrugineus*); from 2000 to 6000 flourishes the Kallege, or Black Pheasant (*Nycthemerus melanotus*), and the Tree Partridge (*Arboricula rufogularis*), commonly called the Peura, or Pura; from 6000 to 9000, the Horned Tragopan, which is called "Moonal" by the natives; and higher still the Three-spurred Pheasant, and a larger species of Pura. Higher still again, in the region of the snows, is found the Himalayan Snow Pheasant.

Whether the Purple Moonal exists in Sikkim I am not able to say, having never seen one. The natives, however, on hearing my description of the bird, say it does.

The above are all the game birds of the pheasant and partridge tribe found, as far as we know yet, in Sikkim; but no ornithologist having yet followed Dr. Hooker's example, and penetrated into the interior of the country, the fauna of it is only known by the collections made by native collectors employed by B. H. Hodgson, Esq., and others.

The other game birds I have noticed are a species of solitary snipe, and the common woodcock.

Ducks are found in the valleys on or near the streams, the course of which they follow up from the plains.

Immense flocks of duck, geese, cranes, and other wading birds of nearly allied tribes, are seen at various times of the year passing high overhead *en route* from the plains of Bengal to their inaccessible breeding places in Thibet.

They do not appear to alight in Sikkim, but when once fairly started from the plains, to fly straight to their destination,

generally by night. The lakes and marshes of India, during the cold weather, abound with these birds, which about April and May commence their migrations to the colder and apparently inhospitable climate of the Trans-Himalaya.

OAKHILL, TORQUAY, *Sept.*, 1863.

THE NEW BRITISH SAND-GROUSE.

(PALLAS'S THREE-TOED SAND-GROUSE—*SYRRHAPTES PARADOXUS*).

BY THOMAS J. MOORE,

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To the students of any department of natural history a new or rare species is always an interesting subject; if it be beautiful in colour, or remarkable in form, the interest is proportionally increased; and if the family as well as the species be an addition to the fauna of his own country, that interest becomes very great indeed.

The ornithologist feels all this at least as keenly as any other naturalist, and his feelings are largely shared by very many, who, though not professed naturalists, yet delight in the wonders and beauties of nature.

The recent occurrence in Britain of numerous specimens of a very handsome bird allied to the grouse kind, and which has only within the last year or two been met with out of its native haunts of Central and Eastern Asia, is a case in point. Here is a bird recently new not only to England but to Europe, chaste and elegant in colour, and certainly most remarkable in form, and no other species of the same family has been known to visit the British islands. Some account of its history, of its occurrence in our own country, and of its structure and relationship, will doubtless be interesting to the readers of the INTELLECTUAL OBSERVER, and particularly so to such of them as are given to ornithological pursuits.

This bird, then, was first made known to naturalists in 1772 by Pallas, a learned and zealous German zoologist and traveller, in the service of the Empress Katharine. He appears, however, to have seen, at that time at least, only a single and not very perfect specimen, brought to him during his travels in Tartary, by one Nicholas Rytschkof, who obtained it in the Kirghiz steppes. Pallas published a figure and description of it under the name of *Tetrao paradoxus*, but without giving any information as to its habits, farther than that it was met within

the sandy deserts about Dshibel Mamut. In calling it a *Tetrao* he followed the arrangement of Linnæus, who included under that generic term both the true grouse of high northern latitudes, and the widely different sand-grouse of the hotter parts of the Old World, with which the *paradoxus* is most nearly allied.

Temminck, early in the present century, proposed the generic term *Pterocles* for the various species of sand-grouse, and, shortly after, Illiger separated from these the single species under consideration, and called it *Syrrhaptes paradoxus*, the name by which it is now recognized by ornithologists. The English name of Pallas's Three-toed Sand-grouse, which has since come into general use, commemorates the name of its discoverer, and refers to one of the peculiarities of its structure (that of its feet), which distinguishes it from all the species of *Pterocles*.

M. Delanoue and Dr. Eversmann appear to have been the next travellers who met with the *Syrrhaptes*, and who published their observations. M. Delanoue describes their walk as slow and laboured, and their flight rapid, direct, and elevated. "The nest is composed of the down of grasses, and placed among sand and stones under a bush. The eggs are four in number, of a *reddish white* colour, spotted with brown. The female quits her nest only at the last extremity. The Kirghiz call these birds *Buldruk;* and the Russians, *Sadscha.*"

Dr. Eversmann states that the *Syrrhaptes*, in the western part of its range, never passes further to the north than latitude 46°; but that eastward it ranges into higher latitudes, being found on the high steppes of the Southern Altai Mountains, on the uppermost course of the Tschuja, in the neighbourhood of the Chinese outposts, where the Mongols call it *Nukturu.*

Skins of these birds have since found their way, at rare intervals, to various public and private collections, from the Gobi Steppe, from Lake Baikal, and from Bucharia; but nothing further became known of their history or range until the summer of 1859, when the first-recorded European specimens were obtained. We next hear of them as being brought, both alive and dead, in prodigious numbers, to the markets of Pekin, from whence several lots were brought alive to England and deposited in the Zoological Gardens of London. Finally, during the present summer, there has been quite an irruption of them in various parts of the country. As the propriety of including this species in the list of European birds rests upon the instances recorded in 1859 and in the present year, it is quite worth while to state them in some detail. Before doing so, however, it may be well to note that Prince Charles Lucien Bonaparte included it in his *Geographical and Comparative List of the Birds of Europe and North America* (published in

1838), as inhabiting Eastern Europe. He at the same time separated the species of *Pterocles* and the *Syrrhaptes* from the true grouse, as a separate family, which he named *Pteroclidæ.* In a subsequent list he omitted the *Syrrhaptes.* Again, with instinctive pertinacity, he added it to the *Catalogue des Oiseaux d'Europe,* published by Parzudaki, the Parisian naturalist, in 1856, but modestly accompanying it with a query. Even this was too much for certain severe ornithological critics, who insisted upon the warrant for its appearance at all being brought into court; and Bonaparte, not being able to produce it, had to abandon the cause of his client.

In 1859 this vexed question was finally set at rest. In July of that year a very fine adult male bird of this species was brought to me in Liverpool, by Mr. Thomas Chaffers, on whose farm, near Tremadoc, it had been shot on the 9th of that month, and was still in the flesh. My first impression was that it had been imported alive, and had escaped from confinement. A moment's examination disproved this most thoroughly; for all birds of the game kind are especially impatient of confinement, shy, and wild, and when imported are always in excessively dilapidated condition, owing to the violent manner in which they knock themselves about in their attempt to escape from confinement or the observation of man. The scalp is generally torn nearly off the head, the wing and tail feathers are broken, and the whole plumage is draggled and dirty. To such an extent is this the case, that there are few more sorry-looking scarecrows than newly-imported birds of this order, and they do not recover their good looks until they have moulted. Here, however, was a bird as nearly perfect as could be. The plumage was unruffled; the delicate prolongations of certain feathers of the wing and tail, especially liable to be damaged, were unbroken, and the whole plumage was beautifully smooth and clean. It was one of three birds observed by a labourer named Quin, on a field of loamy sand, where he was engaged scuffling turnips. His attention was drawn to them by hearing a peculiar "chattering, whistling" noise, and having a gun near at hand, he succeeded in shooting one, the other two flying away, at a height of thirty or forty feet, directly eastward across the river Glasslyn into Merionethshire. They were never seen in the neighbourhood before or after that time. The crop of the one killed contained rape or cole-seed, and seeds of the furze, as kindly determined for me by Dr. Collingwood, Lecturer on Botany at the Liverpool School of Medicine.

Early in the same month, but the precise day unfortunately not stated, a very beautiful male bird was shot in the parish of Walpole St. Peter's, in Norfolk, about two miles from the Wash. This bird is now in the Lynn Museum, to which it was

presented by the Rev. R. Hankinson. At least one other was seen about the same time in the same neighbourhood. A third specimen, also an adult male, was shot on the 23rd of the same month near Hobro, in Jutland. This has been preserved in the Museum of the University of Copenhagen. Finally, a fourth specimen, stated to have been one of a pair observed in the Dunes near Landvoort, in August, 1859, was killed in the beginning of October following, and is now in the collection of the Zoological Society of Amsterdam. That all these birds belonged originally to one flock would seem highly probable. One most competent witness (Mr. Alfred Newton) has seen each of the captured specimens, and declares them all to possess the extraordinary filamentous appendages in nearly perfect condition. The two British examples were fully recorded in the *Ibis*, a scientific journal, exclusively devoted to Ornithology, and the Tremadoc specimen was immediately stuffed, and exhibited before the British Association at Aberdeen, and subsequently before the Zoological Society of London, besides being noticed in the *Zoologist*. Not the slightest attempt has been made to cast a doubt on their having been genuine wild specimens, which had from some unaccountable cause strayed far from their native haunts.

No living specimens had at that time been known to be imported to Europe; indeed, it would be hard to name a more difficult place than their then known habitat from whence to import any object, living or dead; and no person ever pretended to have lost any. Their claim, therefore, to a place in the European and British lists as rare visitors was thenceforward regarded as well-founded.

As *rare* visitors most certainly, yet not quite so rare as until the present year was most naturally supposed; for during the present summer a prodigious number have visited our shores, as the following list will show. The date where given is that when the specimens were observed:—

May 22. A male and female killed out of a flock of about fourteen, at the Isle of Walney, North Lancashire.—Recorded in the *Times*, May 26, by Mr. Schollick.

May 22. Two killed out of twenty at Eccleshall, Staffordshire.—Mr. Yates, in the *Times*, May 28.

May 29 or 30. A very fine adult male, weighing nine ounces and a-half, and in perfect plumage. Recorded by myself in the *Times*, of June 6, as having been killed at Perth, but which I subsequently ascertained was shot at Hoylake, on the coast of Cheshire, where one other was seen.

June 2. A male and female shot near Farnsfield, Notts. Immature eggs of the size of small peas were found in the female. Both birds had been feeding on two or three varieties

of grass seeds, and the leaves of clover. Two others seen.—The *Field*, June 6.

May —. A male and female shot out of twelve or fourteen observed feeding in a grass field within a mile of the Sheffield Moors. (They were erroneously considered to be *Pterocles setarius*, but the description given, "cream-colour and spotted, with very remarkable feet, not unlike a rat's hind feet," proves them to have been *Syrrhaptes.*)—C. Rawson, the *Field*, June 6.

May —. A specimen shot at Royston, Herts, forwarded to Mr. Gould, the eminent ornithologist.

May —. "*A few days before Mr. Schollick's letter appeared in the Times,*" three specimens were shot near Rothbury, in Northumberland.—W. Wilkinson, in the *Field*, June 13.

May 28. Seven made their appearance at Thorpe, Suffolk. "They were observed to come from seaboard, and apparently were compelled to alight on the first landing-place, the beach, through fatigue." A female with immature eggs was shot, and seeds, apparently of plantain or *rumex*, found in the crop.—N. F. Hele, the *Field*, June 13.

May —. A bird of this species broke his wing against a telegraph wire near Lingen, Hanover, and was kept alive some days. A covey of eight was also found not far from Hanover, one of which was shot.—The *Field*, June 6.

No date. A male and female winged by M. Gätke at Heligoland, where they are living and doing well.—The *Field*, June 13.

No date. A brace killed from a flock of nearly a hundred (?) near Oswestry. Buffon and Wilson, Strand, London.—The *Field*, June 13.

No date. A female (?) killed out of a flock of seven or eight, at Eastbourne, Sussex.—C. S. Willes, the *Field*, June 13.

No date. Some shot on this coast, a few miles north of this place.—A. R. A., Boston, the *Field*, June 13.

June 6. A male shot on the sand links of Dornoch, Sutherlandshire. It was a solitary specimen, and "the person who shot it was attracted to the spot by an unusual din created by a number of terns breeding there. They swooped down upon the grouse, and persecuted it in every possible way as an intruder."—W. A. Macleay, in the *Field*, June 13.

June 10. A male and female shot on the beach; only these two birds found.—M. Dodman, Titchwell, near Lynn, Norfolk, in the *Field*, June 13.

June 11. Two brace more shot by the same.—The *Field*, June 20.

June 11. "Fifteen passed towards the south along shore; and yesterday twenty were seen near Thorpe."—N. F. Hele, Aldborough, the *Field*, June 20.

June 4. Eight or nine observed in a grass field at Wrax-

ham, fourteen miles from Yarmouth; three females and a male shot.—H. Stevenson, the *Field*, June 20.

June 8. A male shot on the Dunes at Yarmouth, and two others seen.—*Idem.*

June 9. About forty "flushed once or twice on the beach at Horsey, near Yarmouth, returning each time to the same spot, a sort of hollow in the sands." Fifteen were shot on the 10th, and two on the 11th. The birds in fine condition; their crops filled with grass seed, sand, and fine pebbles.—*Idem.*

June (?) 12. A single specimen killed near Balcombe, Sussex.—The *Field*, June 20.

June 16. A covey of thirteen or fourteen observed on a rabbit warren by the sea-shore, near Drumbeg, Donegal.—W. Sinclair, the *Field*, June 20th. Mr. Sinclair killed a male and wounded a female on the following day. "The captive seems quite contented, was curiously familiar from the first, feeds freely on canary seed, grits, groundsel, etc., and is fond of washing and splashing in a pan of water."—*Idem*, June 27.

May —. "A flock of sixteen or seventeen Pallas's Sand-grouse has remained in the salt-marshes near Teesmouth for several weeks, and only quitted us last week. Three were shot on the 13th ult.," and one subsequently, all males. "They showed every disposition to settle here, but only owe their temporary security to their being taken by our gunners for golden plover, which on the wing they somewhat resemble."—Rev. H. B. Tristram, June 15. The *Field*, June 10.

June 12. A pair killed at Horsey, Yarmouth.—A. W. Crichton, the *Field*, June 20. (These and another brace were served up at the annual dinner of the Acclimatization Society, July 1st, and were pronounced to be admirable by all who had the good fortune to taste them.)

June 7. A pair shot near Saffron Walden; "the crops contained nothing but tares, and the flesh, both in appearance and flavour, was very like that of the common pigeon."—G. Taylor, the *Field*, June 27.

June — . One shot out of a covey of four within three miles of York, and five from a covey of nineteen near Scarborough.—G. Wright, the *Field*, June 27.

June 8. A male shot from a covey of ten or twelve near Wick, Caithness.—H. Osborne, the *Field*, June 27.

June 29. A male and two females in very good condition shot at Mersea, on the Essex coast, on some ploughed land a quarter of a mile from the sea-shore. "They seemed to come direct across the German Ocean; I only saw the three. They pitched down within thirty yards of myself and men."—Quoted by C. R. Bree, M.D., in the *Field*, July 4.

June 30. Nine seen on the beach at Hunstanton, Norfolk; three shot the week previous.—F. Tearle, the *Field*, July 4.

July — . A specimen (the only one seen) killed near Forest Gate, Essex.—J. Withers, the *Field*, July 18.

July — . A pair shot on the coast at Nairn, Donegal.—M. B. Cox, the *Field*, July 18.

July — . A pair shot from a flock of thirteen on the sands at Slapton Ley, near Kingsbridge, South Devon. The birds were in good condition, and had fed sumptuously on grass seeds. H. Nicholls, Jun.—*Idem.*

June — . A specimen "caught in Renfrewshire seven or eight weeks ago, and has thriven well on hemp seed, and is now very tame."—The *Field*, August 1.

"Specimens of this bird have been obtained in 1863 both in Denmark and Sweden, and in May last a small flock was observed, out of which three were shot, flying over a fallow field near Nykopping, in Sweden."—An old Bushman, Sweden, July 31. The *Field*, August 15.

May 28. Two specimens in fine condition shot out of a flock of twelve or fifteen at Munchals, near Aberdeen; crops filled with turnip and grass seeds.—*Edinburgh New Philosophical Journal*, July, 1863.

June 23. A male picked up dead at St. Agnes, one of the Scilly Islands.—E. H. Rodd, in the *Zoologist* for August, p. 8682.

June 10 or 12. A female shot close by the Land's End.—E. H. Rodd, in the same.

May 29. A female killed against the telegraph wire at Box Hill, Surrey; eight seen at Pevensey the day previous.—D. Dutton, *Zoologist*, p. 8683.

May 26. A female shot near Aldershot Camp, and another observed. A day or two after another female was killed out of a covey of nine.—M. A. Matthews, *Idem*, p. 8684.

No date. Two males killed near Barnet. E. Newman, *Idem*, p. 8685.

I have been thus particular in enumerating the places and date of occurrence in order to see what light they would throw upon the subject; and, although it is to be regretted that the precise date has not been given by all the writers quoted, yet enough has been done to show the broad features of the case. Their route across the Continent appears to have been much the same as in 1859. There is no possibility of ever knowing their exact points of departure, but a course very little north of west from the wide range of country they inhabit would bring them to those parts of the Continent which some of them, at least, have passed, and a continuation of the same direction would land them on the coasts of Norfolk and Suffolk, where the greatest numbers appear to have been met with.

If all the specimens observed commenced their westward journey in a single flock, they certainly broke up subsequently into several smaller ones, for the flocks observed in Sweden, Heligoland, and Hanover consisted of a few individuals only. It is not possible to state, from the data given, what was the precise day when they first appeared this year in these islands. The whole arrival is much earlier than in 1859; M. Schollick's is the first published announcement, and also the earliest date precisely given. Mr. Tristram's statement that the flock at Stockton-on-Tees was observed "several weeks" prior to June 15th (the date of his letter to the *Field*) is somewhat indefinite. Mr. Wilkinson's statement that specimens were shot "a few days before Mr. Schollick's letter appeared in the *Times*" is more precise. It would have been worth while, however, to have hunted out, while the facts were fresh in remembrance, whether they were or were not shot before the 22nd, the day on which Mr. Schollick's were killed. Whatever the dates of arrival, however, they speedily spread themselves over the country, but to the north more quickly than to the south. They were shot at Aberdeen on the 28th of May, but were not killed in Cornwall till June 10th or 12th. In Ireland they were observed on the 16th of June, and in the Scilly Islands on the 23rd. Their actual arrival was observed at least on two occasions, but at an interval of more than a month, viz., May 28th on the Suffolk coast, and June 29th on the coast of Essex. Nearly a week before the earliest of these, specimens had been shot by Mr. Schollick on the western shores of England. Indeed, the rapidity with which they spread themselves is scarcely less remarkable than the fact of their reaching the extreme borders of the land; literally from Land's End to John o' Groat's, and from the coasts of Norfolk, Suffolk, and Essex in the east, to those of Lancashire and Donegal in the west; the British Islands would seem not large enough to hold them. That they found food of a suitable kind would appear evident from the number stated to have been in good condition; indeed, not one was said to have been otherwise.

The question as to the cause of these two unusual and most prolonged migrations, is a very tempting, but, I fear, insoluble one. What special circumstances have been in operation during the present summer and that of 1859, which never occurred before, to bring these birds to our shores during the very many years that attention has been closely directed to the visits of rare and strange birds? Of this only can we, I think, be certain, that the causes, whatever they were, originated in their own country rather than here. It is more reasonable to suppose that they were *urged* rather than *drawn* from their home; for what attractive power can we imagine to extend its influence

from here to Tartary? Again, whatever the influence might be, how special must have been its operation NOT to have acted upon other birds peculiar to the same country, for no other such visits have been recorded. The present summer has been remarkable rather for the scarcity of the usual summer visitors; the most unusual wanderers hither, besides the *Syrrhaptes*, are the Demoiselle crane, of North Africa, and some Canada geese; which latter, if the examples observed be not escaped birds, certainly came from an exactly opposite direction to the *Syrrhaptes*. On looking over the pages of the *Zoologist* for 1859, I find that the only unusual eastern bird which was observed during that year, was a specimen of the little bustard (*Otis tetrax*), shot near Oxford, in the beginning of October; but specimens of this species had been shot in England in several previous years, though never in the breeding season; and although it inhabits Tartary, like the *Syrrhaptes*, it by no means follows that any of these wanderers came from thence, for the species inhabits not only North Africa also, but is found as well in several parts of Southern Europe. One fact, however, connected with this species lets in a faint glimmer of light upon this obscure subject. M. Menetries states that these birds are very common at the foot of Mount Caucasus, and particularly so towards the shores of the Caspian sea; and near Baiku, he saw in December, immense flocks of these birds *going in the direction from east to west*. This looks like a migration in the direction of longitude, as surmised, in the case of some other birds, by Dr. A. L. Adams, a most observant Indian ornithologist. Now migration in the direction of longitude will differ from migration in the direction of latitude in this important particular, that the difference in temperature will, in the former, be so slight as to be scarcely appreciable, while in the latter it will rise or fall most rapidly; so that a migration from Tartary, in nearly the same parallel, will not meet that check, in respect of temperature, which would in a northern or southern direction at least exercise some influence upon its extent. Applying these considerations to the case of the *Syrrhaptes*, we yet cannot fail to wonder why their near allies, and our nearer neighbours, the European sand-grouse, have not moved westward too, but, on the contrary, have literally allowed the *Syrrhaptes* to come over their heads! Strange too that these birds should have come in the breeding season, and that so far advanced!

Having now related sufficient to show the extreme interest attaching to the *Syrrhaptes* in a geographical point of view, it will be desirable to describe its structure and relationship a little more fully, to show that its physiological character are quite as remarkable.

The sand-grouse are strictly confined to the Old World, and

consist of numerous species, some or other of which are distributed over the whole of Africa and the hotter parts of Asia; heat, as remarked by Swainson, being as essential to them as cold is to the true grouse. Two species occur in Southern Europe, *Pterocles alchata* and *Pterocles arenarius*, both of which range into North Africa and Western Asia, *but neither of which, nor any other species of the family, has yet been known to visit Britain*—a noteworthy fact when viewed in connection with these sudden inroads of a more distant species. A peculiar style and arrangement of colour pervade the whole group. The ground colour in all is a buffy or sandy hue. This is variegated with black, chesnut, and white or grey. The disposition of these colours varies of course in each species, but they are disposed in either more or less regular stripes or bands, or in spots or blotches. Large and conspicuous masses of colour, when they exist, occur on the under side of the birds. It will thus be seen that the colours and their arrangement are such as to make the birds as inconspicuous as possible in a sandy, arid country, and greatly tending to their preservation from birds of prey.

The type and form of structure is peculiar, and in *Pterocles* is pretty uniform. In size, the species vary from that of a wood pigeon to a turtle dove. The beak is moderate and compressed; in some very slender; the nostrils are placed near its base, and partly closed by a membrane, which is covered above by feathers; legs feathered in front to the foot; toes short and moderately robust; the hind toe small and elevated; tail more or less conical. In *alchata* the two middle tail feathers are lengthened into filaments; wings long, and the first two feathers the longest.

In *Syrrhaptes*, the only other genus of the group yet discovered, the beak is slender and diminutive. The first feather of the wing and the two central feathers of the tail are prolonged into a slender filament, extending two or three inches beyond the other feathers.

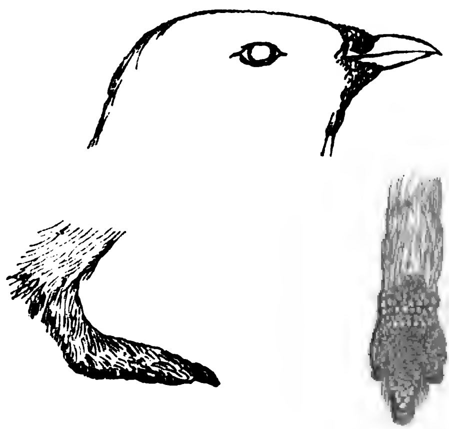
The foot is densely clothed with short feathers down to the claws, which are very broad and strong. *The toes are united together through their whole length*, and covered beneath with plates, which, when well worn, are nearly or quite hexagonal; when less worn projecting in a scale-like manner. The foot thus forms a strong solid pad, well secured from injury from the wearing particles of sand, or the sharp edges and rough surfaces of rocks. No other bird with which we are acquainted has the foot so solid and compact.

Total length from tip of the beak to end of the central tail feather, from 12 to 13 inches; length of wing from the carpal joint to the end of the second wing feather, 8½ inches, the filament of the first feather extending 3½ inches further; tail,

4¾ inches; filament beyond, 3½; length of foot and middle claw, 1 inch; breadth of foot, half an inch; gape, half an inch.

The general colour of the male is pale buff, the head yellowish, the cheeks and throat rufous. The feathers of the back are barred with black, the breast is greyish, bounded with a belt of narrow black lines. A broad black patch, varying in length in different individuals, occupies the centre of the under surface. The sides and vent are whitish, the legs being of a duller white. The wings are tinted with grey, black, buff, and red brown. The tail feathers are barred and striped with black and buff, and are broadly tipped with white, the filaments of the tail and wing are black

The female differs from the male in wanting the filaments



Right Foot. Right Foot.

HEAD AND RIGHT FOOT OF SYRRHAPTES PARADOXUS.

of the wing, in having the head yellow, streaked with black, and the sides of the neck spotted with black. The black bars of the back are smaller and more numerous, and the yellow colour of the throat is separated by a narrow black band from the breast, which is grey.*

The skeleton of the *Syrrhaptes* is as remarkable as the external form. Mr. W. K. Parker, who has made a very special study of the osteology of birds, places the sand-grouse intermediate between the true grouse and the pigeon, and considers the *Syrrhaptes* the culmination of the Pteroclinæ type of

* A fine plate of the male, female, and egg is being prepared for publication by Mr. Gould in the forthcoming part of his magnificent work, *The Birds of Great Britain.*

structure, which, however, he looks upon *as of a very low character*. Not only do certain bones of the skull show a "marked struthious inferiority in the *Syrrhaptes*, but the sternum, which literally unites that of the ptarmigan with its counterpart in the pigeon, is inferior in one important point, not only to this but to the whole Pluvialine group. The heel, which is a mere rudiment in *Pterocles* proper, is absent in the *Syrrhaptes*, and the whole pelvic extremity is almost the counterpart of that of the Swifts in deficient growth. I believe that it would take a very clever anatomist to detect any difference between the wing bones of the *Pteroclinæ* and those of a typical pigeon."*

With respect to the range and habits of these birds, some important information was gained during the late war in China. Mr. R. Swinhoe, an ardent ornithologist attached to the staff of the British army, thus speaks of the *Syrrhaptes paradoxus* in a paper published in the *Ibis* for 1861:—"Your readers will be both surprised and delighted to hear of the abundant occurrence of this species during winter about the plains between Pekin and Tientsin. Flocks of hundreds constantly pass over with a very swift flight, not unlike that of the golden plover, for which we at first mistook them.† The market at Tientsin was literally glutted with them, and you could purchase them for a mere nothing. The natives called them *sha-chee*, or sand-fowl, and told me they were mostly caught in clap-nets. After a fall of snow their capture was greatest, for where the net was laid the ground was cleared, and strewed with small green beans. The cleared patch was almost sure to catch the eyes of the passing flocks, who would descend and crowd into the snare. It only remained then for the fowler, hidden at a distance, to jerk the strings, and in his haul he would not unfrequently take the whole flock. Numbers, however, were shot with matchlocks. When on the ground they were rather shy and difficult of approach, but on the wing they would sometimes dart within a few yards of you. They possess rather a melodious chuckle, the only note that I have heard them utter. The natives say that during the summer they are found abundantly in the great plains of Tartary beyond the Great Wall, where they breed in the sand."

The Hon. J. Stuart Wortley purchased above seventy living specimens in the market at Tientsin, and succeeded in bringing thirty-four alive to England. These he presented to the Zoological Society, Regent's Park. He states (in the Society's *Proceedings* for May 14, 1861), "on our voyage up

* Vide *Proceedings of the Zoological Society of London* for Nov. 25, 1862.

† Several of the observers of the *Syrrhaptes* in England, already referred to also at first mistook them by their flight for golden plovers.

to Tientsin, in the end of August, not a bird was to be seen; and as far as I could learn they had only just begun to appear at Tientsin when we arrived there, on our return, in the beginning of November. Their food must consist of the grain (millet) that covers the whole of that part of China, and I should mention that I fed them on millet the whole way home. The temperature at the time the birds first began to be seen was about 20° Fahr., and later on considerably lower; and on the day we finally steamed down through the ice, which covered the Peiho for fifty miles of its course, the temperature was as low as 10° Fahr., and the grouse were in large flocks on each side."

One of these birds, after its arrival in the Regent's Park, laid a single egg, which is now in the cabinet of Mr. Alfred Newton, by whom it was figured and described in the *Proceedings of the Zoological Society* for 1861, p. 397, pl. 39, fig. 1. Mr. Newton, who saw it a very few hours after it had been laid, says that the colour was then very brilliant, *brown spots showing warmly against a fresh sea-green ground;* a description differing in the ground tint from that given by M. Delanone. It was placed in an incubator, but was shortly after found to be cracked. The only eggs of the *Syrrhaptes* previously known to exist in any collection, were stated to have been obtained by Herr Radde, *in Eastern Siberia,* and are now in St. Petersburg.

Several living specimens were also brought home from China by J. R. Dyce, Esq., Royal Artillery, and were presented to the late Prince Consort, who had them placed in a portion of the royal aviary, specially constructed for them, and in every way adapted to their habits. Dr. Buckland, speaking of these birds, says that they have, in spite of every care and attention, never shown any sign of breeding. Mr. Bartlett believes they would breed in this country if allowed to remain undisturbed in a wild state, though they will not breed in captivity. The birds observed for so long a period near Stockton, seem to have had the best chance of breeding, but no discovery of eggs or young has yet been recorded. Possibly an egg or two may yet be discovered strung among the treasures of some cottage urchin.

In conclusion, I may remark that the genus *Syrrhaptes,* as far as yet known, consists of only one other species, which was discovered by Lord Lilford, by whom it was met with on the banks of the Tsumureri Lake, in the country of Ladakh. He obtained no information as to its habits, and only one other specimen came under his observation. It was described by Mr. Gould, in the *Proceedings of the Zoological Society* for May, 14, 1850, and afterwards figured in his great work on

the *Birds of Asia.* It is of much larger size than *paradoxus*, being fifteen and a half inches in total length. It lacks the prolongation of the wing feathers, and the black colour on the breast; the colouration being otherwise different. Dr. Adams, of the 22nd Regiment, subsequently met with this species on the Salt Lakes of Ladakh, in August, 1852. It has also been observed by Captain Speke.

Finally, great and good service has been done in the cause of British Natural History by the *Field* newspaper, for the history of the occurrences of the *Syrrhaptes* would have been much less complete indeed, but for the notices which have appeared from week to week in the natural history columns of that journal.

[Since the above was in print, the following important communication has appeared in the *Zoologist*:—"This very beautiful and interesting stranger was first observed and shot here on the 21st of May, the weather being very fine, with a moderate easterly breeze. Each succeeding day, up to the earlier part of June, it was seen here in flocks varying from about three, five, fifteen to fifty, and in one or two instances even to a hundred. Out of these nearly thirty have been shot; the earlier birds being, with two exceptions, all very fine male specimens, the later nearly all female birds, every one of them in the most perfect plumage. After a lapse of a fortnight, viz., on the 22nd of June, six sand-grouse again made their appearance; out of these five were shot, all female birds, whose plumage no longer had that fresh and tidy appearance of the earlier instances; so that all through this abnormal and mysterious excursion of this species, they still adhered to the rules of birds on a regular spring migration, that is, the males forming the van, the finest old specimens coming first, after which the females make their appearance, and the rear being invariably brought up by weak, badly-developed or injured individuals of a shabby appearance."—*H. Gatke, Heligoland, July,* 1863, "*Zoologist,*" *p.* 8724.]

THE MORAL FACULTIES OF BRUTES.

BY SHIRLEY HIBBERD.

In an attempt to establish some general conclusions neither new nor strange in reference to the respective spheres of operation of Reason and Instinct (Int. Obs., vol. iii. p. 436), it was held that the only determinable difference between man and animals is one of *degree* and not of *kind*. It is really strange that, after so much has been written and said on this interesting subject, it should be at all needful to prove that the faculty of reason is not given to man alone, but is shared by him in common with the brutes around him, but in a more liberal manner, as the result, in the first place, of Creative Will, and, in the second, of a superior organization. We are oftentimes so deeply and subtly influenced by prejudice that even the truth has the aspect of falsehood, and we renounce a doctrine rather because we do not like it than because we can prove it to be untrue. The doctrine of a community of reason between man and animals is just one of those which the mind is in haste to reject, and in such haste that it prefers not to find reasonable grounds of objection, though data may be close at hand, and in fact within man himself, who is the epitome of the creation.

But there can be no true progress in science unless we are prepared to receive truth as precious for its own sake; and when we begin to observe the habits of animals, and to reason upon the impulses of so-called instinct, we find them to be parallel in every sense to the manifestations of reason in ourselves. The range of brute faculties is by so much narrower than the range of human faculties as this or that order is farther removed from man by inferiority of organization; but the mind is of the same sort in both cases; there is but one mind, and of that animals share a sufficient part for all the exigencies of their life, and something more. Now it is worth asking, if it is possible to separate thought from moral feeling? if it is possible for a creature to think at all without also desiring to think truly and to do well? If the animal races share with man in the power of ratiocination, do they not thereby become, to a certain extent, responsible agents both before God and in the face of nature? We are often told that reason is given us to guide us to what is right, and we must not deny that reason is given to brutes for a similar purpose, and that, if they are not the victims of blind impulse, working wholly in the dark to ends of which they are ignorant, then there must be some-

thing like morality in the animal kingdom, and it is surely worth an endeavour to ascertain what that morality is like.

If I call my pretty Fido, having perhaps missed him from my side for half an hour, I can tell by his reply if he is engaged in mischief, fun, or duty. Those who can hold conversation with animals can best judge what is likely to be the range of their moral feelings; but the most careless observers may take part in the investigation of this subject, for everybody has heard of and seen a "naughty dog." Now Fido knows exactly, as if he had learnt by heart a concise dog's catechism, what is (for him) right and what wrong. I have called him, and he has answered, not with a joyous snap and a bound to follow, but with a tardy snuffle and a slow approach, with his chin scrubbing the ground and his tail doubled the wrong way, and I know thereby that he has found my best carpet slippers and made a beginning of tearing them to pieces. Fido knows he has done wrong; he knows that I shall frown and scold, and that shame will follow upon misdeeds. I repudiate the word instinct while pondering on this event. There is nothing in it that agrees with the definitions of instinct, but I do see in it the glimmerings, and strong glimmerings too, of a power to distinguish between right and wrong; and when I have sufficiently punished Fido, I ask myself why punish him at all if he is not a responsible agent? He wanted amusement, and found it by gnawing the red roses and white lilies out of my fancy slippers, that were worked for me with so much care by somebody who loves Fido as much as I do; just as, when a boy, I found amusement in robbing Captain King's orchard, knowing all the while that I was doing wrong, and anticipating while I did it the nature of the punishment to be endured. But such general indications of moral sense will not satisfy those who come to the consideration of this subject with a burden of prejudices or a spirit of sceptical pride, and so I must ask such to believe that when I am sad Fido is sad, when I am in a spirit of rejoicing Fido's eyes sparkle as if with fire, and he catches my vein of humour and is ready to roll in the moss, gallop wildly through mire and brake, and by every look and gesture exhibit a thorough sympathy with all my moods, and sometimes somewhat of an anxiety to read my thoughts, as I try hard to read his, and flatter myself that I have succeeded perfectly. Now this sympathy between man and brute is an everyday fact: the timid rider puts the hunter out of heart, and he fails to leap fences that, with a confident rider, would be nothing to him. It is the strong sympathy subsisting between the shepherd and his dog, combined with the stern sense of duty which education has made a ruling passion in the breast of that dog, that are the secrets of their

co-working so successfully in the arts of shepherding; and were the dog a stranger to the monitions of the moral law, the sheep must be his prey and not his charge, for the first element of his life is a recognition of the distinction between right and wrong. So all through, so far as man allows an animal to share some part of his domestic life, there is a moral bond of unity, less strong perhaps than that which binds us together in the family and the city, but strong enough for the purpose, and limited only by the contracted capacity of the brute to appreciate the majesty of ideas.

The workings of maternal affection afford a familiar example of one of the finest moral qualities with which Almighty Wisdom has endowed the brute creation. We may call it instinct, but who can draw the line of distinction between the love of a bird for its young and the love of a human mother? In what quality of parental tenderness does the superior creature differ from the inferior? We see in both an anxious care—an anticipating of wants, assiduity which scarcely knows fatigue, devotion which cannot be chilled, constancy unfailing. They differ truly and vastly, but all the fine qualities of the loving woman, which painters and sculptors will endeavour to pourtray to the end of the world, have their counterparts in the heart of the dove, and we may any day learn from the solicitude of an animal for the welfare of its offspring something of the morality of the brute creation.

It would not be a difficult matter to enumerate all the several requirements of the moral law, and point to examples of their fulfilment, not adventitiously, but designedly and intelligently, by animals. But why do we speak of an "honest dog" and a "vicious horse"? It is because we see virtue in the one and vice in the other. But there are honest horses and vicious dogs, and as among men, so among brutes, the beauty of morality is illustrated by the ugliness of crime. All the higher orders of the mammalia exhibit various types of moral excellence as accompaniments to certain peculiarities of cerebral conformation. You know an honest dog the moment your eyes meet his; you will also know a scoundrel dog by his inability to face you, and his skulking gait and downcast, cunning look. Does the bull-dog betray any capability for high moral qualities?—his broad, flat head, his protruding ears, and his forbidding muzzle proclaim him a genuine savage. We should give up hopes of reclaiming such a brute were it not observable that in some instances, in which man and dog are inseparable companions, his master has the same type of head and muzzle, and is also a savage, and if we hope to reclaim the one, why should we not the other? Some men are born criminals, and so are some dogs and horses. Relative morality, like

relative intelligence, is, to a great extent, a question of race—it belongs to the blood; and as we can only hope to reclaim the bull-dog by breeding away from the type, so it is with the man—he will be a human bull-dog to the end of his days; but his children may be an improvement on the parent, and in the course of a few generations the vicious element may be overcome by something nobler.

A Lavater among animals would find it an easy matter to arrange all the higher orders according to their several degrees of moral excellence, according to their cerebral conformations, according to *à priori* considerations, and make but few mistakes. In the elephant, horse, and dog we have the noblest qualities and the noblest types of cerebral development. Faithfulness, courage, affection, and a spirit of unselfish honour are evinced in a remarkable degree by the best examples of these three subjects, and here we find the brain piled up above the sinuses, and the merely animal faculties subordinated to the intellectual, so that there is the capacity for sympathy with man, and the ability also for companionship. Mere intellect would not suffice to render these creatures so adapted for companionship as they really prove themselves to be, any more than cold wit without a spark of generosity will beget for any man much of the love of his fellows. It happens, too, that, as among men, the most intelligent races and the most intelligent individuals exhibit a higher average of virtue, so among animals the quick-witted, easily taught, receptive examples are, for the most part, more confidently trusted with our property and lives. The race-horse, a delicate creature, with a skin like a kid glove, and an organization so refined that he is almost separated thereby from other breeds of horses, frequently exhibits an ungovernable temper, except to the boy who strews his litter, and to him he is as a pet lamb, and may be coaxed with a whisper and flattered by a touch of the hand. But see him defying the strongest jockey at the starting-post to restrain his ardour, and trembling with nervous delight at the plaudits of the crowd, and who can deny that there are strong moral impulses mingled with a quick intelligence in that most enthusiastic of all animal natures?

It is not at all surprising that the animals on which man has most ardently bestowed his energies for their improvement should exhibit high moral qualities and a capacity for higher things than have been accomplished yet. Morality is avowedly an acquisition, though the capacity for it is an essential part of the nature. The rapacious tribes are evidently in a low moral condition, and will ever remain so, as the necessity of their organization and of the limited extent to which it is possible for man to influence them. But, amongst those that have been

most improved, there are differences of degree that sufficiently prove the fact that brutes have not only a physical and an intellectual, but a moral nature; for with some rewards and punishments are mighty engines for good and evil, and with others there is comparative callousness to both. Those who have travelled in old times by the diligence arriving at the Messageries Royale, in Paris, will remember that the white horses employed were of a very pugnacious breed, for no sooner were they liberated from their harness than they fought furiously, without a cause and without method, as Hibernian revellers are said to fight at Donnybrook fair. So those who have enjoyed an acquaintanceship with St. Bernard dogs will have observed that the immense generosity of their natures is such that they may be tormented by demoralized curs till their passions are roused by positive suffering ere they will put forth their strength in their own defence, and adopt the last resource of a forgiving spirit, that of punishing an adversary already completely in its power.

But what, after all, are the qualities that render animals useful to man as companions, protectors, servants, and friends, but those which are strictly in the category of moral excellencies, and capable of still more perfect development as races improve and the effects of education become hereditary? But it is also of importance to recognize the relationship of man and brute in this respect, first for the sake of truth, and second for utility. If we love truth, we shall see in the dog a faint foreshadowing of the highest object of the moral nature of man, for who can doubt that, in some sense, the dog worships his master? On the score of utility it is, at least, worth observing that moral qualities are transmitted by descent, and these should be thought of in selecting animals for the purposes of breeding, no less than qualities purely physical. If it be objected to the conclusions here so generally, and perhaps vaguely, and certainly hastily drawn, that it tends to degrade man to the level of the brute, the reply is, No: it cannot degrade man to be just in his estimates of the capacities of the creatures he makes subservient to his uses, for the first necessity of a moral existence is an admission of a difference between right and wrong, even though, in our mistaken judgment, what we pronounce right may, in the end, prove to be wrong. It may not be hurtful either to science or morality to humble those who deny to brutes any better guiding principle than a blind instinct, and it cannot exalt the brutes, for they are not yet so far advanced in intelligence as to read what is written concerning them. But if it be said that this doctrine is opposed to the truths of religion, I again say, No: because religion, even though it be paganism, has respect for truth as one of its

fundamental principles. As one who has hope in Christ I experience no shock when I discover traces of moral life in the brute, and rather feel a desire to praise God for having so multiplied his mercies as to give to these humbler sharers with me of physical existence a capacity for more happiness than is comprised in merely eating and drinking. I praise Him for making their breasts the abodes of sensations that lift them somewhat above the level of dead matter; and if it be his will that certain races, as horses and dogs for instance, shall improve morally, as well as physically and intellectually, I still see that man is to be the agent of their advancement, and that every step of their progress will be accompanied with benefits to the human race. Religion appeals most strongly and directly to the moral nature; but we may suppose at least that we possess a monopoly of religion, for we ourselves avow it *to be revealed,* and, if revealed, then the moral nature, whether in its crude elementary condition as in the brute, or its more finished, yet still imperfect (and how imperfect!) condition as in man, cannot educe the doctrine by any spiritual generation within itself. There may be the germ of some sort of adoration in the mind of the dog looking full in his master's face with a gaze of absorption, but it is of the same kind as the gaze of a savage at a fetish, and after all the dog worships the man; but it is man's privilege to worship his Maker, and to hope for everlasting union with the Divine Essence. *There* then is a distinction and a difference; but, while we take such comfort to ourselves, let us not trifle with the serious truths of nature, or take refuge in a purposeless pride when we have parted company with reason. A fair recognition of the relationships that exist between ourselves and the brutes may perhaps tend to the cultivation of a spirit of mercy in all our dealings with them, and help forward the day when man shall be at peace with himself and all around him.

ENTOMOSTRACA FROM GIHON.

BY THE REV. CHARLES H. MIDDLETON, B.A.

I INTENDED to have sent you a paper on certain Entomostraca from the pool of Gihon, but I find that the little creatures have been so thoroughly described by Dr. Baird that I can say nothing that has not been said before, and said much better. See *Natural History Review*, 3rd series, vols. iv. and viii. Still this short notice may prove interesting.

A quantity of dried mud from the upper pool of Gihon was sent to England by a friend of mine, Edward Atkinson, Esq., then attached as surgeon to the British Consulate at Jerusalem. It was addressed to Mr. Henry Denny, of Leeds; this was in the year 1858. The following year Mr. Denny sent a part of it to Dr. Baird, putting what remained into an aquarium, which he placed where it should receive as much sunlight as possible. Dr. Baird did the same with the mud sent to him, putting it into water on June 3rd. By June 10th many living creatures had appeared from the ova contained in the mud, and the articles I refer to in the *Natural History Review* contain full descriptions. A fresh parcel of mud from the same pool has since been received at the Philosophical Hall, Leeds, and the whole has for two years lain dry. This year, 1863, it has been placed in water, and has given birth to living creatures which, on reference to Dr. Baird's descriptions, I find to be identical with the species he has named, and with them grows a beautiful Chara. Thanks to the kindness of Mr. Denny, I have had full opportunities for examining the little beauties. Their season is now over; the mud will again be dried, and again next year be watered, when it is hoped the same interesting result will follow. Foremost among the living creatures produced is—

Branchipus eximiis. I have examined one male, two females. They bear a close resemblance to the British species, *Cheirocephalus diaphanus*, described in Dr. Baird's work on Entomostraca in the Royal Society's publications. *B. eximiis* does not attain the size of *Cheirocephalus*, being barely $\frac{3}{4}$ths of an inch in length. The elegant movements of the little creature, the constant waving motion of the branchiæ, and the bright dark eyes, in contrast to the transparent body and bright red of the intestinal canal, make this one of the most beautiful species of the class.

Estheria Gihoni. $\frac{3}{8}$ths of an inch in longest diameter. The brilliant red body, active movements, and transparent shell made this well worth seeing.

Daphnia Atkinsoni, Cypris Celtica, Cypris Orientalis, and

Diaptomus similis are all described by Baird. They bear close resemblance to British species. The shells of all were thickly planted, especially about the anterior portion, with Vorticellæ, who seemed to take advantage of the currents created by the movements of their hosts.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page 255, vol.* iii.)

279. In April a comet near δ Hydræ; in May another (the same ?) comet near π Leonis. In August it was situated within the circle of perpetual apparition.—(Ma-tuoan-lin.)

281 [i.] A comet appeared in September near κ Hydræ.—(Ma-tuoan-lin.)

281 [ii.] A comet appeared in December near α Leonis.—(Ma-tuoan-lin.) This might be the same as the preceding.

283. On April 22 a comet was seen in the S.W.—(Ma-tuoan-lin.)

287. A comet appeared near μ Sagittarii for ten days. Its tail was 100° long.—(Ma-tuoan-lin.) No month given.

290. In May a strange star was observed within the circle of perpetual apparition.—(Ma-tuoan-lin.) Whether a comet or only a temporary star is uncertain.

301 [i.] In January a comet emerged to the W. of β Capricorni, with a tail pointing to the W.—(Ma-tuoan-lin.)

301 [ii.] In May a comet was seen near either ω Capricorni or 110 Herculis.—(Ma-tuoan-lin.)

302. In May—June a comet was visible in the morning.—(Ma-tuoan-lin.)

303. In April a comet was seen in the eastern heavens indicating (*i.e.*, pointing towards ?) ι and κ Ursæ Majoris.—(Ma-tuoan-lin.)

305 [i.] In September a comet was seen in the Pleiades.—(Ma-tuoan-lin.) Under the same date De Mailla places a comet near the Pole.—(*Hist. Gen.* iv. 248.) This is probably the comet of Ma-tuoan-lin, if we suppose him to speak of the *constellation* of the Pleiades in mistake for the *sidereal division* of the same name.—(Hind.)

305 [ii.] On November 22 a comet was seen in the square of Ursa Major.—(Ma-tuoan-lin.) Hind thinks this is the same as the preceding, but Pingré the contrary.

329. In August a comet appeared in the N.W. It approached very near to δ Sagittarii, and was visible for three weeks.—(Ma-tuoan-lin.)

336. On February 16 a comet was seen in the W. near ζ Andromedæ; it was also seen near α Arietis.—(De Mailla, iv. 349.) In Europe a comet of extraordinary magnitude was seen a year or more before the death of the Emperor Constantine, which happened on May 22, 337.—(Eutrop. *Hist. Rom.* x. 8.) Pingré and Hind consider these comets to be one and the same, in which case it must have been visible for fifteen months.

340. On March 25 a comet was seen in the neighbourhood of β Leonis.—(Ma-tuoan-lin; De Mailla, iv. 363.)

343. On December 9 a comet was seen. Its R.A. exceeded that of κ Virginis by 7°.—(Gaubil.)

350. On January 7 a comet with a tail 10° long, and extending westwards, was discovered near κ Virginis.—(Gaubil.)

358. On July 12 a comet appeared, but no position is given.—(Ma-tuoan-lin.)

363. In August — September a comet appeared near α and κ Virginis; it subsequently passed to near α Herculis and α Ophiuchi.—(De Mailla, iv. 413.) During the reign of Jovian, or towards the end of the year, comets are said to have been visible in the daytime.—(Ammian. Marcell. *Res. Gest.* xxv.)

369. From the 2nd to the 7th moon an extraordinary star was visible in the western boundary of the circle of perpetual apparition. The 2nd moon commenced about March 25; the 7th about August 20.—(Hind.)

373 [i.] On March 9 a comet appeared. It traversed the following sidereal divisions, or its R.A. coincided with the following stars:—ϵ Aquarii, α Libræ, κ Virginis, α Virginis, γ Corvi, α Crateris, and ν Hydræ.—(Ma-tuoan-lin.) It is not impossible, however, that the comet did traverse these constellations, in which case the element must have been very small.

373 [ii.] On October 24 a comet appeared near α Herculis and α Ophiuchi.—(Ma-tuoan-lin.) Hind thinks that this was probably *Halley's comet,* which may have arrived at perihelion during the first week of November.

374. In January—February a comet was visible near μ^2 Scorpii and γ Sagittarii.—(De Mailla, iv. 437; Ma-tuoan-lin.) These positions would also apply to *Halley's comet* at this epoch, so it is at present uncertain whether this or the preceding was that body.—(Hind.)

375. A few days before the death of Valentinian, which occurred on November 17, comets were observed.—(Ammian. Marcell. xxx.)

389. In August (probably) a very splendid comet appeared. It rose in the N. at the hour of cock-crowing. Resembling the morning star it burned rather than shone, and ceased to exist in four weeks.—(Marcellin. *Chron.*) It appeared in the zodiacal region, but moving apparently on the left of the spectators, and rising and setting with the morning star it gradually advanced to Ursa Major and Minor. It lasted for about six weeks, and vanished near the centre of the former constellation.—(Philostorgius, *Epit. Hist. Eccles.* x. 9; Nicophoras, *Hist. Eccles.* xii. 37.)

390. On August 22 a comet was seen near α and β Geminorum. Passing the vicinity of β Leonis, ι, θ, and ϕ Ursæ Majoris, it entered the "square" of that constellation; on September 17 it arrived within the circle of perpetual apparition. Its tail was 100° long.—(Ma-tuoan-lin.) It lasted four weeks.—(Marcellin.) It is certain that two large comets appeared in two successive years, and what is equally remarkable, that they both followed nearly the same path from the zodiac to the pole; the first was seen, or at least recorded, only in Europe; the latter was seen both in Europe and China.—(Hind.)

392. A comet appeared.—(Couplet.)

395. A great comet appeared in August, which moved from ϵ Sagittarii towards β Aquarii, and α Equulei.—(De Mailla, iv. 496.)

400. On March 19 a comet 30° long appeared in the sidereal division θ Andromedæ. It rose to υ Cassiopeiæ and stopped to the W. of the circle of perpetual apparition; it entered the "square" of Ursa Major, and arrived near λ, μ, etc. In the next moon (commencing April 11) it passed by β Leonis to β and η Virginis.—(Ma-tuoan-lin; Gaubil.) The most terrible comet on record. Its form was that of a sword.—(Socrat. *Hist. Eccles.* vi. 6.)

401. In January a comet appeared near δ Cygni.—(De Mailla, iv. 57.)

402. In November—December an extraordinary star appeared to the W. of the region lying around β Leonis; two moons later it was nearer that star.—(Hind.) "It first appeared in the E. towards that part of the heavens where Cepheus and Cassiopeia shine. Passing then a little beyond the Great Bear, it overpowered by [the brilliancy of] its wandering hair the beauty of the stars of that constellation, till at length it languished, and finally dissipated itself in a very feeble flame."—(Claudian. *De Bell. Get.* xxvi. 228, *et seq*).

415 [i. and ii.] On June 24 two comets were observed near α Herculis and α Ophiuchi; passing by the former star they stopped to the N. of π and σ Scorpii.—(Ma-tuoan-lin.)

Probably this route applies to only one of the comets. From another Chinese chronicle it appears that on June 18, 416, two comets were visible. It is most unlikely that in two consecutive years in the same moon, and on the same day of the moon (Chinese reckoning), two pairs of comets should have appeared, so (as Pingré suggests) probably there was only one pair, one or other of the two historians having accelerated or retarded their appearance by one year.

418 [i.] On June 24 a comet was discovered in the middle of square of Ursa Major.—(Ma-tuoan-lin; "Cette comète diffère nécessairement de la suivante," Pingré.)

418 [ii.] "On July 19, towards the eighth hour of the day, the sun was so eclipsed that even the stars were visible. But at the same time that the sun was thus hid, a light, in the form of a cone, was seen in the sky; some ignorant people called it a comet, but in this light we saw nothing that announced a comet, for it was not terminated by a tail; it resembled the flame of a torch subsisting by itself without any star for its base. Its movement, too, was very different from that of comets. It was seen at first to the east of the equinoxes; after that, having passed through the last star in the Bear's tail (probably η Ursæ Majoris), it continued slowly its journey towards the west. Having thus traversed the heavens, it at length disappeared, having lasted more than four months. It first appeared about the middle of summer, and remained visible until nearly the end of autumn."—(Philostorg. xii. 8.)

In China the comet was seen on September 15 in Leo; it rose above δ or σ Leonis, and passed through the square of Ursa Major, the circle of perpetual apparition, and near ι and κ or λ and μ Ursæ Majoris.—(Ma-tuoan-lin.) It was first seen near δ Cygni, and was visible for eleven weeks.—(De Mailla, iv. 590.) Couplet states that it appeared at the end of November or the beginning of December. If for *appeared* we could read *disappeared*, the accounts would harmonize.

419. On February 17 a comet appeared in the west of the region lying around β Leonis.—(Ma-tuoan-lin.)

420 or 421. In May a comet was seen.—(Couplet.) In Europe a wonderful sign appeared in 421.—(Prosper. Tyron. *Chron.*) Was this the comet of the Chinese?

422 [i.] In March a star with a long white ray appeared for ten nights about the time of cock-crowing.—(*Chronicon Paschale.*) On March 16 it was near α and β Aquarii.—(Gaubil.)

422 [ii.] On December 18, a comet was seen near α and β Pegasi.—(Ma-tuoan-lin.)

423 [i.] On February 13 a comet was seen near γ Pegasi, and α Andromedæ.—(Ma-tuoan-lin.) A comet was frequently

seen before the death of the Emperor Honorius.—(Marcellin.) This event happened in August.

423 [ii.] On December 14, a comet was seen near α and β Libræ.—(Ma-tuoan-lin.)

432. A comet was seen near α and γ Leonis; passing in the vicinity of β Leonis it disappeared near α Boötis.—(Ma-tuoan-lin.) No moon given.

436. On June 21 a comet was seen near π Scorpii.—(Gaubil.)

442. On November 1 a comet, without a tail, was seen in the square of Ursa Major. It soon threw out a tail, and passing θ Ursæ Majoris, through Auriga, ρ and π Tauri, came to π Ceti, and γ, δ, μ Endami. It disappeared in winter.—(Ma-tuoan-lin.) It appeared in December and remained visible for several months.—(Marcellin; Idatius. *Episcop. Chron.*)

449. A comet appeared on November 11, near β Leonis. —(Ma-tuoan-lin.)

467. A comet resembling a trumpet was seen for periods of from ten to forty days in the evening sky.—(*Chron. Pasch.*; Theophanes, *Chronographia*, p. 99. Paris. 1655.)

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The annual meeting of the British Association, held at Newcastle-upon-Tyne, during the end of August and commencement of September, was one of the most successful in point of numbers and financial results of any that has been held for some years. The number of members actually attending amounted to 3356, of whom 1004 were ladies; and the total receipts reached the sum of £3600. From this the amount of £1750 has been granted for the purpose of carrying on scientific inquiries during the next year. In the inaugural address the president, Sir William Armstrong, recorded the most important scientific discoveries of the past year, and indicated the probable progress of science during the ensuing period. The history of locomotion was traced from the date when the pack-horses carried a load of three hundredweight from the coal-pit to the shipping place on the Tyne, down to the present time, when the locomotive engine conveys a load of 200 tons, at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying three hundredweight an equal distance.

The possible early exhaustion of our coal-mines, the source of

all our manufacturing wealth, was seriously considered. The facts that, theoretically, a pound of coal is, by its combustion, capable of producing sufficient mechanical energy to raise ten million of pounds one foot high—that in our best constructed steam-engines only one-tenth of that result is obtained—and that with our ordinary engines not even one-third of this lower amount is produced, were carefully considered; and the inference drawn that in our average steam-engines thirty times as much fuel is required as would be requisite with a perfectly-constructed heat-engine.

The possible substitution of some new source of motive power was considered; the fact that we cannot obtain mechanical energy without the consumption of materials demonstrated; and that no materials could possibly be so cheap as the coal from the earth and the oxygen of the air; the latter costing nothing, and every pound of coal rendering available two and a-half pounds of oxygen as a source of power. The reason that the materials of water cannot be regarded as a source of power is that the oxygen and hydrogen are already chemically combined, and require the expenditure of a great amount of chemical energy to effect their separation.

The time when we shall utilize the natural falls of water as sources of mechanical energy was regarded as inevitably, though slowly, approaching; and one great river was stated to develope at a single plunge sufficient power to carry on all the manufacturing operations of mankind, if they could be concentrated in its immediate neighbourhood.

The waste of coal in our ordinary households was a subject of regret. In warming by open fires we consume at least five times the amount of fuel requisite in a well-constructed stove; and as one pound of coal in an efficient steam-boiler is capable of evaporating one gallon or ten pounds of water, the amount of fuel wasted in our ordinary fires may be readily inferred.

The increase of temperature below the earth's surface, as measured at the Monkwearmouth colliery to a depth of 1800 feet, was stated to agree closely with that observed in other localities, namely, to be one degree Fahrenheit for every 60 feet. This, assuming the fusing point of subterranean minerals to be 3000°, would give a thickness to the earth's crust of about 34 miles, and would from the mere increase of temperature prevent the working of mines to as great a depth as 4000 feet.

In connection with the dynamical theory of heat, the circumstance that every degree of heat (Fahrenheit) in one pound of water is equivalent to 772 pounds lifted one foot high was stated, and also that these amounts of heat and power were reciprocally convertible into one another. This led to the consideration of the explosive force of gunpowder, which first appears as heat and then takes the form of mechanical power, communicated chiefly to the shot; which force is reconverted into heat when the motion of the shot is arrested in striking an object.

After alluding to the resolutions of Mr. Tyndall on radiant heat, which have been described in our previous volumes, Sir W. Armstrong advocated strongly the introduction of the metric system of

weights and measures, and the centigrade division of the thermometer, and recommended the Association to exclude all other standards from their future publications; and concluded by a consideration of, and a qualified assent to, the Darwinian theory regarding the origin of species.

Many of the topics of the papers read in the different sections of the Association have been already mooted in the different scientific societies, and have been duly chronicled in our pages. Among the most interesting of those not noticed may be mentioned that of Mr. A. Claudet on the refractive power of the eye, by which objects that are situated in reality somewhat behind us appear as if situated to the left or right; or, in other words, that objects are pictured in the retina which are included in an angle much larger than half the sphere of which the observer is the centre.

From the refractive power of the cornea, rays passing through it are more and more refracted in proportion to the angle at which they strike its surface; the only objects seen in their true position being those whose rays enter the eye perpendicularly to its surface; rays entering at an angle of 90° are refracted 10°, and appear to come at an angle of 80°.

Some curious illusions result from this law. I may suggest the following experiment. Connect two lights placed at some yards distance from each other by a strained thread, on placing the face over the centre of the thread, and looking at right angles to it, both lights are seen somewhat in advance of the body, as if forming an angle of 160°, and if the observer turns his back on the thread and walks away from it, both lights remain visible, so long as the angle formed by them does not exceed 200°; hence we are really enabled to see behind us whilst looking straight in front.

Mr. Claudet called attention to another effect of this phenomenon. That on placing ourselves so that the sun is on one hand and our shadow on the other, the sun and shadow do not appear connected in one line, but that they are bent to an angle of 160°, and are both seen a little before us. The intellectual observer of these phenomena need hardly be reminded that the head should not be turned to either side during these experiments.

The paradoxical and apparently impossible action of Giffard's injector, employed instead of a feed pump in charging steam-engine boilers, was illustrated in a remarkable manner by the Abbé Moigno, with M.M. Bourdon and Salleron's "Injector of Solids."

Giffard's injector consists of three tubes united at one point: one of these brings the supply of water for the boiler from any convenient source; the second is for the purpose of conveying the water into the boiler, and opens below the level of the liquid in that vessel; the third brings a jet of steam from the upper part of the boiler. This jet of steam has the power of injecting a constant supply of water into the boiler, and so obviating altogether the necessity for a feed pump, and, apparently impossible as it may appear, not only has the steam power to inject water into its own boiler, but it is capable of feeding another boiler in which the steam has a much higher pressure than itself. MM. Bourdon and

Salleron's Injector of Solids, which is capable of rendering this action visible by means of solid bodies, consists of two air vessels, with a communicating tube capable of being opened or closed at the will of the experimenter. One of these vessels is made of glass, and furnished with an aperture closed by a valve opening inwards. The other has a small air-gun proceeding from it, the barrel of which is directed against the opening in the first vessel. On condensing air into the two receivers, it is found that, even when four atmospheres are condensed into the glass vessel, and only two in that connected with the air-gun, the bullet driven by the latter has power to open the valve closed by the pressure of four atmospheres and enter the glass receiver.

The paper read by Dr. Embleton on the Anatomy of a Chimpanzee strongly corroborated the facts brought forward by Professor Huxley and Mr. Marshall, that the brain of this animal differs only in degree—that is, in the smaller size and extent of its parts—from that of man; and that with this difference essentially the same structures, without any exception, exist in both brains.

Dr. Crawford maintained in a subsequent paper that the consideration of the material structure of the brain was of far less value than a consideration of its working or living action, and that probably there exist subtle differences between the brain of man and those of the lower animals that anatomy has not, and probably never will, detect.

Thus the brain of the wolf is anatomically the same as that of the dog, one being an untamable glutton, the other the friend and companion of man. The Australian savages tame the young of the wild-dogs, and use them in the chase, whereas the young of the wolf are not capable of complete or useful domestication. Again, the hog, with its low organized brain, is equal in intelligence to the most anthropoid monkey. The sheep and the goat have brains identical in structure, the one being a stupid, the other an intelligent animal.

Among the more singular new instruments exhibited at the meeting must be mentioned M. Soleil's Tenebroscope, for demonstrating the invisibility of light; this was shown and described by the Abbé Moigno. It illustrates the fact well-known to scientific observers that rays of light are invisible except the eye is so situated as to receive them either directly or as reflected from surrounding objects.

This is decisively shown when a beam of sunlight is admitted into an otherwise perfectly dark chamber, and received on a piece of black velvet or other non-reflective surface; when the whole chamber remains in perfect darkness, and the ray of light itself is perfectly invisible except that small portion of it which is reflected from the atoms of dust floating in the air. On powdering some small dust in the course of the beam, or by pouring a shower of water across it from a small watering can, it becomes immediately visible; and the chamber itself may be instantly illuminated by receiving the beam on any reflective surface. M. Soleil's Tenebroscope consists of a tube closed at one end, the other being open to

admit of being looked into. The interior is blackened, and there is an opening in the side to admit a strong light to pass across the tube. When looked into from the end, the tube is perfectly dark despite of the light passing across it; but on raising a small white ball into the course of the rays of light, they instantly become visible from being reflected so as to enter the eye of the observer.

NOTES AND MEMORANDA.

Sugar from Serpents' Skins.—M. S. de Luca obtains small quantities of sugar by chemical transformation of a substance existing in the skin of serpents, and which is isomeric with vegetable cellulose. The existence of this substance under such circumstances affords another connecting link between animal and vegetable organic bodies.

Poisonous Effects of Thallium.—M. Lamy calls the attention of the French Academy to the poisonous properties of thallium, to which he ascribes pain and lassitude chiefly in the lower members, which he experienced while experimenting on that metal and its compounds. He dissolved five grammes of sulphate of thallium in milk, and offered it to two puppies, who tasted it and left it alone. Two fowls, six ducks, and a moderate-sized dog obtained accidental access to the milk. The dog was soon taken ill with sharp pains, and his hind-quarters were partially paralyzed, after exhibiting convulsive movements. Iodide of potassium was administered as an antidote, but the animal died in sixty-four hours, having been affected neither by vomiting nor alvine dejections. In the evening after the milk had been swallowed one fowl and six ducks died. Four days afterwards the two puppies died. All the creatures suffered paralysis of their lower limbs. The second fowl was killed on the eighth day, having for three days been in a bad state, and unable to stretch its neck sufficiently to pick up food.

The August Meteors.—M. Coulvier-Gravier has a short paper on this subject in *Comptes Rendus*. He says that "in August, 1861, he pointed out the year 1858 as terminating the descending period, since 1848, when the phenomena were at their height, and on the 9th, 10th, and 11th August 110 shooting stars appeared per hour. In 1858 the number had descended to 39·3, while in August, 1863, he noticed 66·7 per hour." He adds that we may soon expect the August showers to re-appear in all their magnificence.

Bread from Pompeii.—In August last year a baker's oven was discovered in Pompeii, closed with an iron door, and containing eighty-one loaves of a brownish colour. M. S. de Luca, who examined some of this bread, and reported to the French Academy, found that the loaves still contained some moisture, which they parted with at 110° to 120° C. The central portion contained about 23 per cent. of water and the exterior only 19 to 21 per cent. The quantity of carbon diminished from the circumference to the centre, while the hydrogen followed an opposite rule; thus it would seem that the decomposition took place very slowly, and was not affected by sudden and strong heat. The central parts were least affected, and contained the largest quantity of the elements of nutrition.

Poisoning by Nitro-Benzole.—*The Proceedings of the Royal Society*, No. 56, contain an important paper by Dr. Letheby on the above subject. It appears that if a dose of nitro-benzole be not too large, its poisonous action will not be immediately apparent, but it may "destroy life by a lingering illness, which shall not only defy the skill of the physician, but shall also baffle the researches of the jurist." After death the blood of animals so killed is black and turbid, and the large organs congested, and no nitro-benzole can be discovered, if sufficient time has elapsed, as it will then be converted into aniline. Such facts show the necessity of having medical men well trained in chemistry. Aniline produces symptoms very similar to nitro-benzole. The conversion of the latter into the

former takes place in a dead stomach, or by contact with putrid flesh for several hours.

CAUSES OF COAGULATION OF BLOOD.—Professor Joseph Lister observes, in the Croonian Lecture, which details elaborate experiments, "that the coagulation of the blood is in no degree connected with the evolution of ammonia any more than with the influence of oxygen or of rest. The real cause of the coagulation of the blood when shed from the body is the influence exerted upon it by ordinary matter, the contact of which for a very brief period effects a change in the blood, inducing a mutual reaction between its solid and fluid constituents, in which the corpuscles impart to the liquor sanguinis a disposition to coagulate.—*Proceedings of the Royal Society*.

ATMOLYSIS.—Professor Graham gives this name to operations of *dialysis* conducted with gases, the molecules of which pass through tubes of unglazed earthenware, or plates of graphite, with unequal velocities, so that a separation, more or less complete, of mixed gases, can be effected by this means. He says, "the most remarkable effects of separation are produced by means of the *tube atmolyser*. This is simply a narrow tube of unglazed earthenware, such as a tobacco-pipe stem, two feet in length, which is placed within a shorter tube of glass, and secured in its position by corks, so as to appear like a Liebig's condenser. The glass tube is placed in communication with an air-pump, and the annular space between the two tubes maintained as nearly vacuous as possible. Air, or any other mixed gas, is then allowed to flow in a stream along the clay tube, and collected as it issues. . . . In the gas collected, the denser constituent is thus concentrated in an arithmetical ratio, while the volume of the gas is reduced in a geometrical ratio. In one experiment the proportion of oxygen in the air, after traversing the atmolyser, was increased to 24·5 per cent., or 16·7 upon 100 oxygen originally present."—*Proceedings of the Royal Society*, No. 56.

ROSS'S NEW COMPRESSORIUM.—Microscopists who have suffered the inconvenience inseparable from ordinary forms given to a compressorium, will thank us for calling their attention to an entirely new pattern devised by Mr. Ross. It consists of a stout plate of brass about three inches long, having in its centre a piece of glass like the bottom of a live box. This piece of glass is set in a frame which slides in and out, so that it can be removed for the convenience of preparing any object upon it, under water if desirable. The upper moveable part, attached to a screw motion, is admirable for simplicity and efficiency. At one end of the brass plate, which forms the bed of the instrument, is an upright piece of brass, accurately grooved so as to receive a vertical plate, to which a downward motion is given by a single fine screw, surrounded by a spiral spring, which elevates the plate as soon as the screw pressure is removed, by turning the milled head the reverse way. The vertical plate carries an arm precisely at right angles to its own plane, and terminating in a square frame capable of receiving very thin or somewhat thicker glass according to desire. This is the upper part of the compressorium, and the exact amount of pressure required is completely under command by the motion of a single screw. The arm has likewise a horizontal motion, so that the upper glass, plate can be turned completely off the lower one. Should the thin upper glass be broken, it can be instantly replaced, as no cement is required. It is merely needful to remove the fragments, and slip a fresh glass in. We do not know any compressorium that is at once so accurate and so easily used. If required, a duplicate frame, carrying a thin bottom glass, can be obtained, and it would be very easy to contrive a support, as in the pattern of M. Quatrefages, by which either side of the object could be viewed. It often happens that on account of the trouble of an ordinary compressorium, a microscopist simply uses a slide and a piece of covering glass, and finds when too late that an exact means of regulating the pressure would have been desirable. With Mr. Ross's new pattern the convenience is so great that it should always be employed if there is a chance of the screw motion being advantageous.

EARTHQUAKES AT RHODES.—M. Jouanin, *gerant* of the French Vice-Consulate, gives an account in *Cosmos* of the disturbances in that island since 1860; and he likewise mentions a severe shock which occurred on 12th October, 1856, accompanied by vertical oscillations. In the year 1860 earthquakes occurred

in January, February, and June; in 1861, they occurred in May, June, July, and August, in the Isle of Niceros; and in May, 1862, at Marmoritza, a part of Anatolia, twenty-five miles from Rhodes. In June, July, and August, 1862, Rhodes itself experienced shocks, which were repeated twice in March, and three times in April, 1863. On the 22nd April the shocks were violent, and a gyratory motion felt. The barometer sank considerably between four o'clock in the afternoon of the 21st and the same hour on the 22nd, six and a half hours before the shock. A violent north-west wind which had been previously blowing, stopped during the earthquake, and in a few minutes regained its force. In 1856 the south-west part of the island chiefly suffered; but in April, 1863, the south-east part was most affected. In the village of Mossari not a house was left, and 130 out of 200 inhabitants perished. The shock was felt simultaneously at Rhodes, Smryna, and Alexandria, and on the coasts of Syria and Asia Minor. The adjacent islands, likewise, felt it, and two ships passing between Cussos and Scarpanthos were violently affected. The writer states that from the beginning of 1863 the sea did not return to its usual level; two days before the earthquake it was lower than ever, but after the shock it regained the old level, and sometimes went beyond it. After the great shock five lesser shocks occurred in April, and four in May.

Bolides at Rhodes and Dust-shower.—The writer of the preceding mentions a magnificent bolide that burst over the island on 12th March, 1863, at one a.m. It moved from east to west, exploded like a bomb, and scattered fragments in all directions. After its disappearance two fresh detonations were heard, followed by prolonged humming. The sky was brilliantly lit up, and the light lasted some minutes after the passage of the meteor. A similar bolide appeared on the 17th March, at seven p.m., but it was smaller and made no explosion. In the night of the 28th and 29th March a strong south-west wind brought a quantity of yellowish dust, which fell in showers and covered all the vegetation.

Material for Photographic Lenses.—M. Gaudin states that rock-crystal is the best material for photographic lenses, on account of its permitting the passage of the largest quantity of actinic rays. The editor of *Cosmos* observes:—"It is evident that a transparent substance which gives a passage of the greatest quantity of the violet and extra violet rays, would be best adapted to the construction of active lenses."

Solid Matter in Rain.—M. Robinet states that the rain falling in Paris holds certain solids in solution, the quantity being usually, though not always, greater after drought. As a rule the quantity of solid matter diminishes as the shower is prolonged. Paris rain contains chiefly sulphate of lime, and an organic matter of which little is known. The sulphate of lime is sometimes present to the extent of twenty grammes in a cubic metre. He adds, that rain-water froths on agitation more than other water, and that in Paris it yields red tints, with nitrate of silver, and deposits a garnet-coloured precipitate.—*Comptes Rendus*, 7th Sept., 1863.

The Bouquet of Wine.—M. Maumené recently addressed a letter to the French Academy, in which he states that the flavour of certain wines can be obtained by adding to ordinary wine a few drops of a liquid composed as follows:—He distils sixty litres of fresh wine lees, mixed with water, in a chloride of calcium bath, and as soon as the fluid he obtains emits an odour of wine, he adds a cubic centimetre of essence of pears, one volume of Valerian-amylic ether, and six volumes of alcohol at 36° strength. If too much is added the flavour of the pear becomes apparent. By adding two drops of butyric ether the flavour of good Vin de Bouzy is imitated. He says those ethers are most successful in which the acid and the base have both high equivalents.

The Natterjack in Lancashire.—Mr. Wm. Tyrer, of Leamington, alluding to the recent paper by Mr. Couch, informs us that, "The Natterjack is very abundant in South Lancashire in all the ditches, in those parts near the coast, and also in pools of water among the sandhills. It makes a very peculiar noise in the summer evenings, and in the parish of North Meols is known by the name of Meols' Organ."

SLIMONIA (*Pterygotus*) ACUMINATA, Salter. Sp.
Upper Ludlow Rock. Lesmahagow. ½ natural size. —From a specimen in the British Museum,

THE INTELLECTUAL OBSERVER.

NOVEMBER, 1863.

ON THE "SERAPHIM" AND ITS ALLIES.

BY HENRY WOODWARD, F.Z.S.

(With a Tinted Plate.)

PERHAPS there is no class of people more happy in the choice of names for natural objects than our quarrymen and pitmen. Every collector of fossils has heard of the "Fairy-loaves" (*Ananchytes*) and "Thunder-bolts" (*Belemnites*), the "Files" (spines of *Cidaris*), "Bird-tongues" (teeth of *Lamna*), and "Slugs" (palatal teeth of *Ptychodus*, etc.); of "Devil's toe-nails" (*Gryphæa incurva*), "Rams'-horns" (*Ammonites*), "Screw-stones" (casts of Encrinite stems), "Dragon's-skin" (*Lepidodendron*), and "Cupid's-wing" (a form of iron pyrites); possibly also of the "Seraphim," a fossil found in "the Arbroath paving-stone" of Forfarshire, which from the wing-like form of some parts of the shell, and the scale or feather-like markings upon its surface, has given rise to this angelic title among the natives. The fragmentary state in which this curious fossil occurs, rendered its correct determination a matter of extreme difficulty. Professor Agassiz, who was the first palæontologist that undertook to solve this zoological problem, writes*:—"The more I know of this creature, the more I am tempted to believe that it was a *fish;* but how absolutely decide upon it when we have neither head nor tail, but only large wings? It may provisionally bear the name of *Pterygotus problematicus*, Ag. (wing-fish)." Fortunately, however, before the publication of his work on the Fishes of the Old Red Sandstone (1844), Agassiz had an opportunity of examining more perfect remains, collected by Mr. Webster in the neighbourhood of Balruddery in Scotland, by which he was enabled to learn that what he had at first conceived to be a

* Murchison's *Silurian System* (1839, p. 606), "Plate IV., Figs. 4 and 5, belong undoubtedly to the same animal as the Seraphim of the Old Red Sandstone;" and Fig. 6, described as *Sphagodus pristodontus*, Ag., a new genus of fishes, is *now* also known to be the serrated edge of the foot-jaw of a Seraphim.

fish was, in reality, the remains of an enormous crustacean; and the supposed scales were surface markings on its shell. Although unable correctly to determine the nature of the fragments which he figured in Plate A of his *Fossil Fishes*, Agassiz yet most justly concluded to place it "between the Trilobites and the Entomostraca," making it the type of a new family, and including with it *Eurypterus and Eidothea*, two fossil genera since shown to be closely related to *Pterygotus*.*

In 1855, Professor McCoy published in Sir Charles Lyell's fifth edition of his *Manual of Elementary Geology*, p. 420, a restored figure of *Pterygotus problematicus*, Agassiz, which, now that we have a more correct notion of these queer-looking fellows, seems very much like a funny caricature, such as Edward Forbes not unfrequently indulged in.

In September of the same year, Mr. Robert Slimon read a paper before the British Association at Glasgow,† on the Geology of Lesmahagow, Lanarkshire, and exhibited a collection of *Pterygoti* and other associated fossils from Logan Water, which Mr. Salter described and figured soon afterwards in the *Quarterly Journal of the Geological Society*‡ (vol. xii., 1856), with a Report on the Geology of Lesmahagow by Sir. R. I. Murchison, in which Mr. Slimon's observations are embodied, and his labours as a geologist are honourably and deservedly mentioned. In fact, but for the zeal of that gentleman, we might to this day have remained unacquainted with some of the most perfect and wonderful specimens of the tribe.

The foregoing is a nearly complete bibliography of *Pterygotus* to 1859, when Messrs. Huxley and Salter published in Memoir No. 1 of the Geological Survey, their monograph, comprising eleven species of *Pterygoti* (and one of *Eurypterus*), and illustrated by sixteen folio engravings, and many woodcuts.

On referring to Page's *Advanced Text-Book*, second edition, also published in 1859, although the old generic name *Himantopterus*§ is retained, and some other inaccuracies repeated,

* In June, 1862, Mr. J. W. Salter published in the *Quarterly Journal of the Geological Society*, vol. viii., p. 386, an account of the chelate limbs of *Pterygotus problematicus*, from the U. Ludlow Rock of Herefordshire.

† Mr. David Page also read a paper on the "Seraphim" of the Old Red Sandstone at the same meeting, and exhibited a restoration of it. His observations have been reprinted in the *Advanced Text-Book of Geology*, 1856, p. 135.

‡ Under the generic name of *Himantopterus*, four species are described:—*H. bilobus*, *H. perornatus*, *H. Banksii*, *H. lanceolatus*; and two *Pterygoti*—*P. acuminatus and maximus*. In 1856, Mr. Salter also read a paper at the British Association Meeting on the great Pterygotus of Scotland, and other species.

§ This name having been already used to express a genus of Lepidopterous insects, could not, according to the rules of the British Association, be retained for a section of the Pterygoti.

which we shall presently refer to, it is evident Mr. Page's collection contained more perfect specimens of *P. acuminatus* than the officers of the survey were acquainted with, and which have only been surpassed by specimens very recently obtained for the national collection by Mr. Bryce M. Wright (36, Great Russell Street), and collected by Mr. Robert Slimon, of Lesmahagow. That figured in our plate is perhaps the best example, and represents an almost entire specimen of *Pterygotus** *acuminatus*, Salter (so called from the peculiar pointed form of the tail-joint). It is only one-third the natural size, the original being twenty-seven inches in length. The largest individual of this species I am acquainted with would have measured, if entire, more than three feet in length, and nine inches to one foot across its widest body-segment. The smallest perfect specimen of this species in the British Museum measures six and three-quarters inches in length, and one inch across its widest segment.

P. acuminatus is the largest species found at Logan Water. A restoration in correct proportion to the size of the fragments of the great *Pterygotus anglicus*, from the Lower Old Red Sandstone of Perthshire and Forfarshire, would give us a creature measuring from six to eight feet† in length, and more than a foot wide! It is an interesting fact to notice that the largest crustacean living at the present day is the *Inachus Kæmpferi* of De Haan, from Japan‡ (a brachyurous or short-tailed crab, nearly related to *Maia squinado* of our own shores); whilst the *Pterygoti* are not only related to the lower and more simply organized living crustacea, but those also which are least in the scale in point of size.§

It needs but a slight acquaintance with the Crustacea to perceive that the *Pterygotus* is a most remarkable and anomalous creature. The head alone appears to possess any separate organs, and these are adapted at once to serve the multifarious purposes of feeling, locomotion, prehension, and mastication.||

The oblong square carapace¶ (A 1), with its large sessile eyes at the anterior angles; the heart-shaped plate in the centre (*e*),

* The genus *Slimonia* of Page, 1856, was founded upon this species, although not properly constructed or defined.

† Mr. Salter is of opinion that *P. problematicus* from the Downton sandstone, and *gigas* from the Ur. Ludlow Rock, attained dimensions fully as large. See his restoration of *P. anglicus* in Murchison's *Siluria*, new edition, 1859, foss. 21, f. 1.

‡ It is not the size of the carapace for which this crab is remarkable, but the extraordinary length of its limbs; the fore-arm measuring four feet, and the others in proportion; so that it covers about twenty-five square feet of ground.

§ Honourable exception must, however, be made in favour of *Limulus moluccanus* (the great King crab) of China and the Eastern seas, which, when adult, measures one and a-half feet across the carapace, and three feet in length!

|| The feet in some Crustacea also serve the office of branchiæ.

¶ Not seen *in situ* in the large specimen, but figured separately A 1.

called the *metastoma*, or post-oral plate,* covering the buccal cavity;† the three pairs‡ of simple, many-jointed, and spiny palpi (*a, b, c*); the two broad and oar-like appendages, evidently serving as organs of natation (*d d*), like the last pair of feet in recent swimming crabs (see woodcut, Fig. D, foot of *Platyonichus ocellatus*). Each pair of organs have their terminal joints serrated at their basal edges, thus serving the offices of foot-jaws and mandibles.

The thorax and abdomen are composed of twelve joints or segments, which are terminated by a finely-pointed, spear-shaped tail-plate. The first six segments have each a pair of sub-central, spine-like ridges near their posterior margin, probably indicating the points of attachment for muscles within, and are ornamented upon their surface with those peculiar scale-like markings (Fig. *h a*) which led Agassiz at first to place them in the class of fishes, as already stated. No appendages of any kind have been found belonging to the body segments of these animals, except that about to be described. This plate, seen *in situ* in our engraving (*f*, and also in woodcut, Figs. G and K, *m*), covers the ventral surface of the first thoracic§ segment, and is divided into three parts—a median lobe, the extremity of which overlaps the succeeding segment, and two lateral lobes united with it, forming the "conjoined *epistoma* and *labrum*" of Messrs. Huxley and Salter. This plate is placed in front, on the under side of the head, in the restored figure of *P. anglicus*, given in Murchison's *Siluria*, already referred to (see foot note, page 231). Mr. David Page was so fortunate as to possess proof of the true position of this curious segment, which he has figured in the second edition of his *Text-Book of Geology* (1859), p. 163, Fig. B, and it is there described as "the anal plate;" but I am not acquainted with any of the *Articulata* in which that plate occurs in the position indicated; indeed, there does not appear to be any authority for such a determination.

On recently examining some scorpions from Smyrna, I was much struck by the analogy existing between the general arrangement of their organs and those of *Pterygotus*. The locomotory appendages, for example, are all cephalic, and their

* Serving in place of a lip, or lower jaw in higher animals; the true mandibles and accessory organs of manducation working *laterally* in nearly all the Articulata.

† The specimen is lying upon its back, having, therefore, the ventral surface displayed to view.

‡ Five pairs of organs are known to have existed, see restoration.

§ This appears really to consist of two parts, or segments united together; that next the head being much narrower than the other, thus making the number of segments twelve, as stated, without the tail-plate. This number of segments can be distinctly made out in *P. bilobus*, and both Mr. Slimon and I consider it also demonstrable in *acuminatus*.

basal joints serve the office of *palpi*. The two first pairs of organs are chelate. The eyes are six to eight in number, and are placed, two near the centre, and two or three upon each anterior angle of the carapace. The body segments are robust, and the tail long and narrow, and terminated by a cordiform tail-plate, finely pointed at its tip. The reproductive organs are placed immediately behind the mouth; but as the scorpions belong to the *Arachnida* (a division of the *Insecta*, which, although closely approaching the *Crustacea*, is distinguished from them by always breathing by means of *tracheæ*, whilst the latter are furnished with *branchiæ*), we must seek for true affinities among the *Crustacea*, properly so called.

In *Limulus* the true organs of locomotion may be said all to belong to the cephalothorax, and are arranged around the mouth, their basal joints serving the office of *palpi* and mandibles (see woodcut, Fig. A). The abdomen is furnished on its under side with a series of lamellæ; the first of which (Fig. B) overlaps and nearly conceals the succeeding five. They are all exactly like the upper one externally; being, in reality, only a modification of the abdominal swimming feet of the lobster and other *Macrura;* but the first is said to belong to the thorax, and carries upon its inner surface the reproductive organs (Fig. B, *a*), whilst the five which succeed it support and shield the *branchiæ*, or gills. These organs of respiration are constantly vibrating during life, as may be seen in the specimens kept in the fish-house of the Zoological Gardens. The eyes are placed on either cheek, upon the upper surface of the horseshoe-shaped carapace, very much as in the Trilobites. They are compound, and present a beautiful facetted structure when seen through a pocket-glass. Two larval eye-spots may also be detected in the centre of the carapace* in front. Although the shell of *Limulus* appears to be composed of only two parts—the one representing the cephalo-thorax, and the other the abdomen, terminated by a long, powerful, spine-like appendage—yet, on examining it carefully beneath, we see traces of sutures, indicating the division of the abdomen into five separate segments, as in many other crustacea.†

The first organs of *Limulus* are a pair of small *chelæ* placed in front of the mouth (woodcut, Fig. A 1); they correspond to

* Larval eye-spots are found both in the *Pterygoti* and *Eurypteri* of America; see Hall's *Palæontology*, and also in the carapace of the great *Pterygotus anglicus* of England.

† Several small *Limuli* occur both in the coal measures of Coalbrookdale and in Ireland, and it seems probable, from Mr. W. H. Baily's observations, that their abdominal segments were moveable and not fixed, as in the living King crabs. See explanation of sheet No. 137, p. 12—14, Geological Survey, Ireland, 1859, and *Annals and Mag. Natural History*, s. 3, vol. ii., pl. 5.

the antennules of higher crustacea; the second pair (A 2) are much larger, but chelate like the first; these are the *antennæ*, their bases serving as *palpi*, or foot-jaws. These and the three succeeding pairs of organs (A 3, 4, and 5) are alike in the female *Limulus*, but in the male the antennæ are peculiarly modified (woodcut, Fig. C)—a sexual distinction found also to exist in many other living crustacea.

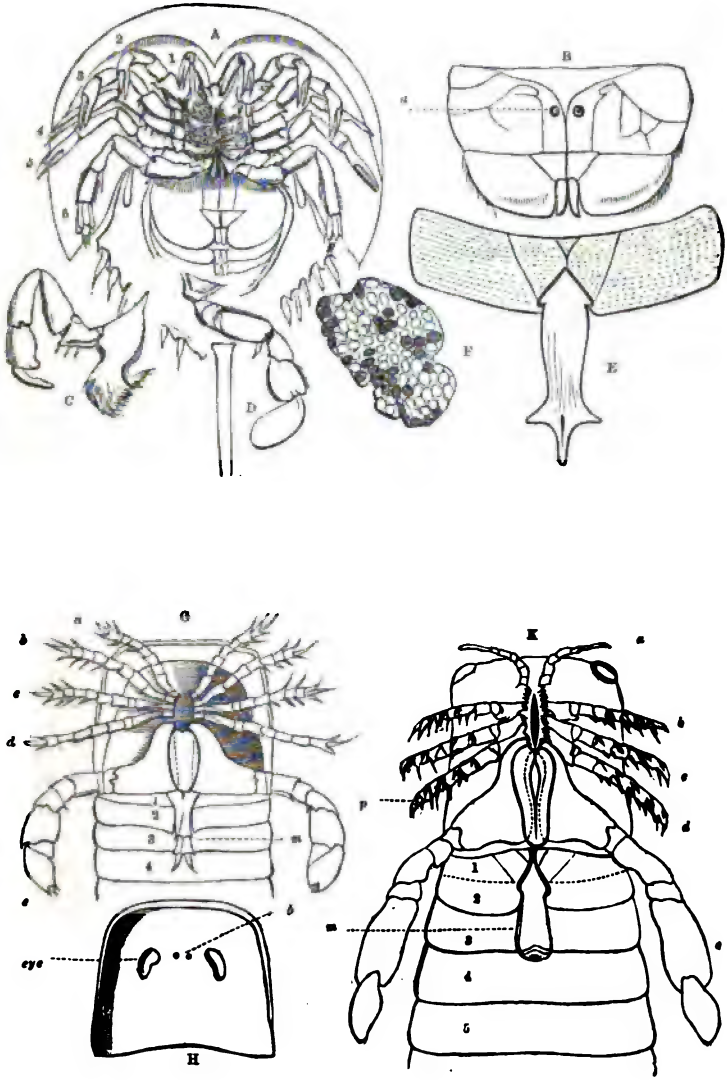
I have thus minutely described *Limulus* because of its affinity to *Pterygotus*, and to its fossil congener *Eurypterus*; and now that we are enabled to give a correct restoration of *P. acuminatus* (see woodcut, Fig. K), its relation to the living form is still more clearly seen.

Having fully satisfied myself as to the general homologies that existed between the nature and position of the organs of the living *Limulus* and scorpion, and the extinct *Eurypterida*, especially as to the identity of the thoracic appendage already referred to, my satisfaction was very much increased on subsequently finding that, in 1859, Professors Hall and Agassiz in America, and, some years since, Mr. Robert Slimon in Scotland, had each independently arrived at the same conclusion, from the study of widely different specimens of the same fossil group.

Mr. Hall writes (p. 394*), "Professor Agassiz regards the central organ attached to the lower side of the first segment as similar to the appendage attached to the membranous feet behind the swimming feet of *Limulus* (see woodcut, Fig. B); and, instead of being double, is anchylosed as in young *Limulus*. Since my comparisons had been made almost entirely with *Limulus*, I am prepared to appreciate these views of Professor Agassiz."

Mr. Slimon writes me, "It is a number of years since I found that plate (see frontispiece, *f*, *g*, and woodcut, Fig. K *m*), but it being detached I could form no conception of what it was, and many palæontologists who saw it were equally at a loss to explain its nature. At last I found one *in situ*, which threw some light on the subject; still its use remained a mystery. After some time I obtained the other kind of plate (see woodcut, Fig. E), attached to an individual of the same species (*P. acuminatus*). This led me to the conclusion that it was connected with the sexual organs, and that one form of plate would indicate the male and the other the female. Lately I have observed something like eggs (Fig. F) lying near plate E; so, probably, this may prove to be the female." * *

* See *Geological Survey of New York*, vol. iii., "Palæontology," 1859, by James Hall, Esq. On the genus *Eurypterus*, pp. 392—413; *Dolichopterus*, pp. 414, 415; and *Pterygotus*, pp. 416—419. Plates 80, and nine following plates, and plate 84 *a*. From which the figure of the head of *Eurypterus* (restored) is copied (woodcut, Fig. G).



Note.—For explanation of these figures see page 237.

* * * "I have also observed two forms of thoracic plates in the other species (*P. bilobus*)."*

We have given a figure of the upper portion of *Eurypterus remipes* (De Kay), after Hall's *Palæontology of New York, loc. cit.*, and by its side the same parts of *P. acuminatus*. *P. bilobus* is a very much smaller species than *P. acuminatus*, and instead of small, simple, and slender antennules,† it has large and strong *chelæ* or claws like the great "Seraphim," only on a very much smaller scale. The succeeding organs in *P. bilobus* are slender and unarmed, whilst those of *P. acuminatus* are robust and spiny on every joint. The thoracic and tail-plates, too, are quite distinct in shape, and so also is the cephalic shield and the form of the eyes. Feeling as I did the importance of these distinctions, amounting to far more than specific characters, I was much rejoiced at obtaining the independent sanction both of Messrs. Huxley and Salter to place it in a separate genus, adopting for it the name proposed by Mr. David Page—*Slimonia acuminata.*‡

The additions which we have been able to make (with the kind assistance of Mr. Slimon) towards the completion of *Slimonia acuminata,* consist in indicating another thoracic segment; so that the number of body joints is now the same in *Pterygotus* and *Eurypterus,* increasing the number of organs from three to five pairs, and demonstrating the true position and character of the thoracic plate. Only one other point of interest remains to be solved, namely, the position and form of the respiratory organs, and upon this subject we are not without good hope.

We must now conclude our brief sketch of this remarkable palæozoic crustacean. Those who wish to enter more fully into their history must refer to the monograph of Messrs. Huxley and Salter, the Quarterly Journals of the Geological Society, Professor Huxley's Lectures on Crustacea (printed in the *Medical Times and Gazette* for 1857), and Hall's *Palæontology of New York* for 1859. And all who desire to observe for themselves, should bear in mind that the actual specimens can be seen and studied in our public collections at the British Museum, and the Geological Survey, Jermyn Street.

* The median lobe of plate E, and an almost entire detached thoracic plate of the form figured in woodcut K, were figured in Messrs. Huxley and Salter's monograph; but, not being found *in situ*, were attributed to the mouth as the conjoined epistoma and labrum.

† The antennules of *P. acuminatus* have their basal joints serrated, so as to form the first pair of mouth organs. The antennules of *P. bilobus* do not seem to be furnished with serrated basal joints, a most important distinction.

‡ Page's *Advanced Text-Book of Geology*, 1856, p. 135, f. 3; in compliment to my friend, Mr. Robert Slimon, of Lesmahagow, the discoverer of all the Lanarkshire specimens.

Explanation of Plate of *Slimonia* (*Pterygotus*) *acuminata*, Salter sp.—Fig. A 1. Carapace of *S. acuminata*, about one-third natural size, showing the sessile eyes at the angles of its anterior margin (the antennules are not clearly to be seen in this specimen) : *a*, first pair of simple palpi (*antennæ*) ; *b*, second pair of ditto (mandibles) ; *c*, third pair of ditto (first *maxillæ*) ; *d d*, entire swimming feet, with their broad basal joints, whose serrated edges serve the office of *maxillæ* ; *e*, post-oral plate, or *metastoma* ;' *f*, thoracic or genital plate, covering reproductive organs, and concealing the two first thoracic segments, with its median lobe (*g*), which was described as the conjoined epistoma and labrum ; *h*, *i*, *k*, *l*, third, fourth, fifth, and sixth thoracic segments, the first and second are concealed beneath the thoracic plate (*f*) ; *m*, *n*, *o*, *p*, *q*, *r*, six abdominal segments. The thoracic segments are broad and short, whilst the abdominal are long and narrow ; *s*, telson or tail-joint ; *h*, *a*, a small portion of one of the thoracic segments highly magnified, showing the characteristic squamose markings upon its surface.

Explanation of Woodcuts.—Fig. A. Recent *Limulus*, "King crab "(female) : 1, antennules ; 2, antennæ ; 3, mandibles ; 4, first maxillæ ; 5, second maxillæ ; 6 (swimming feet), third maxillæ. Fig. B. Thoracic appendage, covering reproductive organs (*a*). Fig. C. Antenna of a male *Limulus* (recent). Fig. D. Foot of swimming crab (recent), *Platyonichus ocellatus*. Fig. E. Thoracic appendage of *Slimonia acuminata*. Fig. F. *Parka decipiens*, supposed eggs of *Pterygoti*. Fig. G. Head of *Eurypterus remipes*, De Kay (after Hall's figure), *under side*, exhibiting the organs of the mouth : *a*, antennule ; *b*, antennæ ; *c*, mandibles ; *d*, first maxillæ ; *e*, (swimming feet) second maxillæ ; *p*, post-oral plate, or metastoma ; *m*, thoracic appendage ; 1, 2, 3, 4, thoracic segments. Fig. H. Upper side of same, showing the eyes, and (*b*) larval eye-spots. Fig. K. *Slimonia acuminata* (restored) ; the letters refer to the same parts as in *Eurypterus remipes*.

THE MINUTE STRUCTURE OF THE VINEGAR PLANT.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

AMONG the minute organisms which puzzle the microscopist the Vibrions and their relatives present great difficulties as regards their structure and classification. Ehrenberg assigned an animal nature to the whole family; but it is far more probable that all are, as some are known to be, vegetable, and perhaps rudimentary conditions of more highly organized plants. In *Pritchard's History of Infusoria* (fourth edition, p. 187) the results of Cohn's investigations are cited, and we find it laid down by that naturalist that "the Vibrionia apparently all belong to the vegetable kingdom, for they exhibit an intimate affinity with undoubted Algæ." Dr. Burnett is also quoted in the same place to the effect, that "their cell structure and their vital (not voluntary) motion would lead us to infer that the Vibrionia are algous plants, and not animals. This throws light on several common phenomena. One in particular is that the Vibrionia should almost invariably be found in infusions and liquids that contain other Algæ, and especially the common Torula; for I do not remember to have seen the Torula without Vibrionia."

It affords more precision to regard Algæ and Fungi as distinct classes of the sub-kingdom *Thallophytes;* and the Torula, with which Dr. Burnett found the vibrions associated, is ranked among the Coniomycetous Fungi, and is closely connected with the Yeast and Vinegar Plants.

It is not an easy question to define what is a vibrion, because minute bodies more or less divided into beads may differ widely in their origin, their properties, and their destination. In decomposing solutions objects of this kind invariably appear, and the researches of Pasteur, which are recorded in former numbers of the INTELLECTUAL OBSERVER, and which I, therefore, shall not quote at length, lead to the conclusion that all kinds of fermentations and putrefactions are acts correlative with the growth of these remarkable organisms; and that their life, so to speak, presides over the decay and disintegration of higher animal or vegetable beings, and of the complicated products which they form.

Minute, and usually colourless, thread-like bodies of beaded structure, exhibiting a wriggling or oscillating motion, and destitute of organs (for the alleged filament of bacterium is probably a mistake), are readily recognized as belonging to the vibrion family; but the motion, though a common property,

does not seem an essential characteristic, and we shall only follow good authorities if we admit quiescent objects, which have the same form and exercise analogous functions, as members of the same family.

The usual divisions of vibrions into genera and species, we apprehend, satisfy nobody. Some are larger, some shorter, some divide obliquely, some at right angles to the longer axis. Some are like miniature corkscrews, and so far resemble that pretty confervoid plant the Spirulina. These latter move spirally, and often with rapidity. Others twist and wriggle, others oscillate, and others stand still.

The *Micrographic Dictionary* provisionally places some vibrions among the confervoid Algæ, and probably all will be distributed between the Algæ and the Fungi, the latter seeming most likely, to the writer, to carry off the greatest number.

In *Pritchard's Infusoria,* p. 531, the genus Bacterium, of Dujardin, is described as characterised by straight slightly flexible threads more or less distinctly jointed, and *slow* in their movements. In the next page all the species are said to have an *active* power of locomotion. The activity of motion certainly does not afford ground for generic or specific distribution, and some that are active at one time appear to be quiescent at another. For convenience, Dujardin's division may be adopted, as founded upon external characteristics easily distinguishable in extreme cases, though liable to be more or less confounded in intermediate forms. According to this, first comes *Bacterium,* the description of which we have just cited. Then we have "*Vibrio,* either straight or flexuose, with a more or less vivacious writhing movement;" and then "*Spirillum,* having the form of a corkscrew, revolving on their long axes, oftentimes with great rapidity, but never straight." They are all small bodies; few exhibit the beaded structure with less than an amplification of 500 diameters, and some defy a power of 2000 linear, which leaves them extremely minute in length, as well as in breadth. Ehrenberg constituted six genera of vibrions; and Pasteur, speaking of them, says that they can all exist without free oxygen, and perish in contact with it, if nothing preserves them from its action.* To *Monas crepusculum* and *Bacterium termo* he ascribes the disappearance of oxygen from putrefying infusions, and then he tells us the vibrions appear and do their work as *ferments,* pulling to pieces the complicated organic atoms in a definite way. If this view should be confirmed, it may serve as the foundation for a natural division of the vibrion family: those which live in oxygen and perform one set of functions being distinguishable by action and habit, if not always by appearance, from those which perish in oxygen

* See INTELLECTUAL OBSERVER, Sept., 1863, p. 101.

and perform functions of a different kind. Bacteriums, etc., form a well-known pellicle on the surface of organic solutions, and this pellicle, as M. Pasteur tells us, is usually associated with moulds and mildews, an observation coinciding with the statement of Dr. Burnett that torula and vibrions are commonly found together.

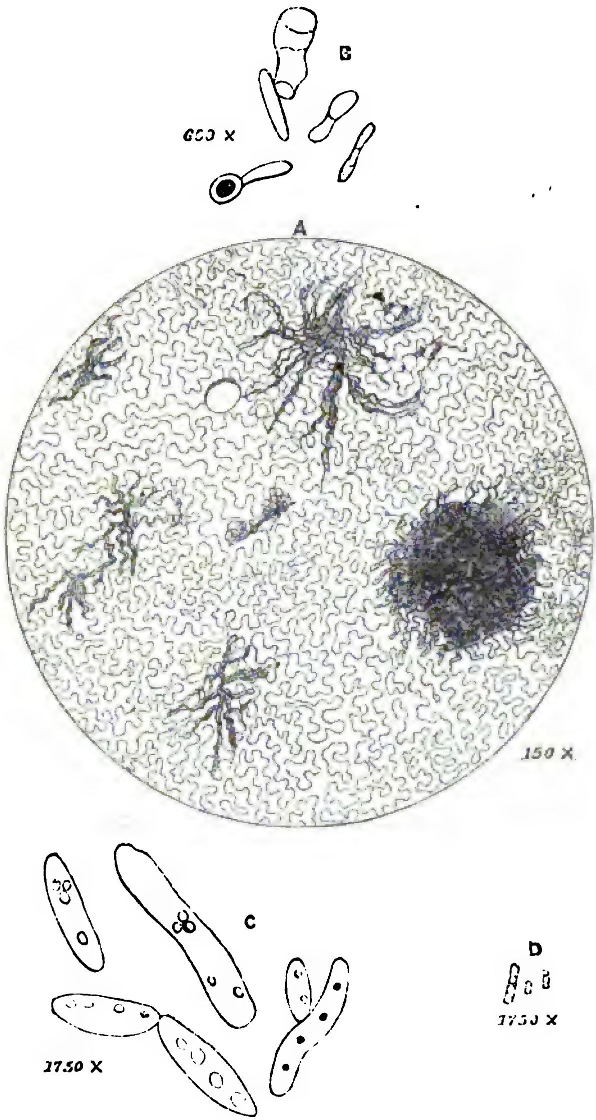
If we were to follow M. Pasteur in calling the "ferments of putrefaction" *vibrions*, we might call similar small bodies concerned in vinous or acetous fermentation *bacteriums*; that is to say, supposing we could connect such bodies with all processes of that sort, purely chemical ones excepted. When putrescence occurs in a liquid exposed to air, M. Pasteur represents the vibrions as determining changes in the body of the liquid, while the bacteriums and mucors burn the products of the vibrion action, and bring them back to the simple condition of binary compounds.

The INTELLECTUAL OBSERVER, vol. iii., p. 271 (May, 1863), contains another of M. Pasteur's papers, in which that distinguished investigator expresses the belief "that a considerable number of beings that can live without air determine different kinds of fermentation." Those without motion he calls *vegetable*, and those with motion *animal*, thus following Ehrenberg into untenable ground. In a previous paper, given in the INTELLECTUAL OBSERVER for September, 1862, "On a New Process of Vinegar-Making," the same author shows that the mycoderms of wine and vinegar act as agents for conveying the oxygen of the air to a crowd of organic substances; and in the still earlier paper (already cited),* he speaks of this oxydizing faculty as existing in various degrees among the mucedines, and also among the smallest of the infusoria, by which we presume he means members of the vibrion family. Are we not, from these facts, justified in considering that the oxydizing vibrion may be closely connected with the fungi of similar action? and towards this the minute structure of the vinegar plant points.

The *Micrographic Dictionary* observes that, from various observations, the vinegar plant may be regarded as the mycelium of *Penicillium glaucum*† vegetating actively, and increasing also by crops of gonidia, or gemmæ. It adds "that the moniliform growth is, at the same time, scarcely distinguishable from the yeast plant by any satisfactory character, and repeated observations strongly impress us with the idea that these objects are all referable to one species—the vinegar plant being the form of vegetative growth taking place at low or ordinary temperatures in highly saccharine liquids; while the

* See INTELLECTUAL OBSERVER, vol. i., p. 242.

† The *Penicillium glaucum* is the common blue mould.



THE VINEGAR PLANT.

true yeast plant, or torula, is formed in the more rapid fermentation, taking place at more elevated temperatures."*

The vinegar plant, commonly so called, is a tough, leathery mass, often used by private families to make vinegar out of solutions of sugar and treacle; but the same plant exists in a more delicate and diffused form when other modes of vinegar-making are employed; and M. Pasteur shows that it coats the shavings, or twigs, over which some manufacturers cause a suitable liquid to flow when they desire to promote its acetification. If a thin piece of the large, tough vinegar plant is examined microscopically, a moderate power suffices to show what the *Micrographic Dictionary* describes; namely, an unorganized jelly and cellular structures of many shapes, often resembling coherent cells of yeast; others being like oïdium, etc., etc. It is also, in those I have examined, easy to see something like an entangled mass of minute threads; but, when this structure is carefully treated, myriads of bacterium bodies appear, and are found to constitute the chief bulk of the plant itself.

I am not aware that these bacterium bodies have been described before, and I will therefore explain the process by which I became acquainted with their existence. First a small, thin strip of the vinegar plant should be torn off from any part on or below the surface. This should be placed upon a glass slide, moistened with a drop of water, and stretched out by means of a camel-hair pencil-holder and the back of a penknife. When reduced by stretching and squeezing to a film not exceeding a 250th or a 300th of an inch thick, cover with thin glass, press steadily, and view with a high power, using the achromatic condenser and a small stop. An immense quantity of little thread-like bodies will then be seen; and, if the power be sufficient and the illumination carefully adjusted, a beaded form will appear sufficiently often to indicate the class of object to which they belong. That the little bacterium bodies have not been obtained by tearing big ones to pieces in the stretching process will be plain upon examination of the plant in different conditions of extension and thickness.

I have employed in this investigation Smith and Beck's $\frac{1}{20}$th and second eye-piece, giving a magnification of 1750 linear, with occasional resort to their first eye-piece, reducing the power to 1000 linear, or to their third, bringing it up to 3000. A minute drop of solution of iodine, followed by another minute drop of dilute sulphuric acid, facilitates the view of the beaded structure; but it can be made out without such aid when the eye has got used to the object, and the illumination is suf-

* This theory is doubtful, as the alcoholic fermentation goes on slowly and at low temperatures with the German sediment yeast.

ficiently careful. I do not think all the little bodies are beaded, but conceive that they tend to become so, and I think the amount of division and distinction of one bead from another varies according to the stage of growth. The size of these bacterium bodies varies; thus, after examining portions of a large adult plant, I find entered in my note-book that large ones on that occasion were 1-8000" long, and small not half as much. On the same occasion it was with extreme difficulty I could make out a beaded structure in any of the bodies, while on others I saw it, as I find entered, in "scores."

Occasionally I saw bacterium bodies not distinguishable from those in the gelatinous mass, swimming close to the edge of the portion under examination; but I could not be certain whether they had been set free by the tearing and stretching, or whether they had never been embedded in the mass. I think, however, the former was the case.

After two or three fragments of a large plant had been undisturbed about a week in a Preston salts bottle containing water with a little sugar in solution, I found a thin, delicate new plant about one inch in diameter floating at the top. This, on being viewed with a power of 150, exhibited the appearance of the accompanying sketch, the dark threads consisting of strings of beads, apparently spores. Whether old or young, a quantity of larger cells will be found embedded in the gelatinous mass. Some of them (drawn from the young plant) are shown in the sketch, and will be found to contain smaller cells. These little cells (gonidia?) were sometimes isolated, sometimes approximated; and on one occasion I thought one of the larger cells contained two bacterium bodies, each composed of three or four beads. The position of the object was, however, unfavourable for determining this with certainty.

Mitsherlich's observations on yeast may throw light upon these cells containing spores or gonidia. He tells us that the *unterhefe*, or sediment yeast of the Bavarian beer, is propagated by spores thrown out from the larger cells, and not by buds or offshoots, as is the case with surface yeast.* I do not mean to assert that the large cells in the vinegar plant are yeast cells, although I think it probable; but, if not, they may be cells of the same plant in a different condition, and therefore requiring a separate name, although several conditions and several names may, after all, have to be grouped together as sub-names of a single species of plant.

The larger cells not only vary in shape and contents, but also in position; some are isolated, others collected in small associations, while in other spots hundreds are approximated in a more or less regular pattern.

* *Miller's Chemistry*, vol. iii., p. 105.

The bacterium bodies probably give rise to the tough mucus in which they are involved, and the unorganized mass in which they are embedded in the vinegar plant may only differ in density from the more delicate material in which the same kind of bodies are enveloped when they form a pellicle on the surface of infusions, or adhere in a more or less globular shape. On this subject the remarks of Dr. Arlidge, in the first part of *Pritchard's Infusoria*, may be cited with advantage. He says, "When we come to examine an infusion rich in these organisms, numerous jelly-like colourless masses of different size and figure may be met with on the walls of the vessel, and on the surface of the fluid. These, when young, resemble small balls, from 1—1000″ and less in diameter; but as they continue constantly to enlarge, they acquire a clustered outline, and exhibit themselves as colourless masses, and films of very considerable superficial dimensions and thickness, resembling soft palmellæ in consistence. Like these, they are composed of a transparent mucus, in which numberless punctate or linear corpuscles are embedded." Now, if we could make the mucus more dense and tough, multiply the "punctate or linear corpuscles" indefinitely, and introduce a sprinkle of larger cells analogous to those of the yeast, we should have a vinegar plant as its structure appears to me.

The yeast plant is shown, as already stated, to be intimately connected, if not identical with, several vegetable forms to which distinct names have been assigned; but, both upon botanical and chemico-physiological grounds, it would be very interesting to ascertain to what extent that form of it known as the vinegar plant is associated with bacterium bodies. It is not enough that in one or two cases we find quantities of these bodies present when alcohol or saccharine matter is converted into vinegar—the question is, are they always present, and do they seem to be the particular agents by which the vinegar-making is carried on. To ascertain this, the vessels of various sorts of vinegar works should be examined, and when the process is conducted by suffering a certain fluid to trickle over twigs or shavings, it should be ascertained whether bacterium bodies appear in quantity together with, or as a *component part of the Mycoderma aceti*, of which M. Pasteur speaks.

Omitting those cases in which vinegar or acetic acid results from purely chemical processes, such as the destructive distillation of wood, or the influence of spongy platina, it appears to be obtained by the action of vegetable ferments on saccharine matter or alcohol, neither of which can be present in *excess* without stopping the process. Certain other substances in small quantities are also required to be present, or the growth of the organic bodies cannot proceed. In Germany, where alcohol is cheap, vinegar is made directly from it. Large

vats are fitted up with perforated shelves, on which a quantity of beech or deal shavings, first dried and soaked in strong vinegar, is placed. A mixture, consisting of one part of alcohol, sp. gr. 0·850, of six of water, and 1000th of honey, yeast, or wort, is allowed to trickle slowly through the shavings, while the temperature is raised to about 80° F. The acetification does not proceed rapidly until the process has been in operation for some days,* that is to say, until the vinegar plant has had plenty of time to grow. Spongy platina will oxydize alcohol and generate vinegar as the vinegar plant does, although probably not *precisely* in the same way; but, however, alcohol becomes changed into acetic acid, Professor Miller considers that the formation of aldehyd always precedes the production of vinegar by an oxydizing process, and he gives the following formula as expressing what takes place when alcohol is thus transformed :—

$$\overbrace{C_4\,H_6\,O_2}^{\text{Alcohol.}} + 2\,O = \overbrace{C_4\,H_4\,O_2}^{\text{Aldehyd.}} + 2\,HO; \text{ and}$$

$$\overbrace{C_4\,H_4\,O_2}^{\text{Aldehyd.}} + 2\,O = \overbrace{HO,\,C_4\,H_3\,O_3}^{\text{Acetic acid.}}$$

When vinegar is obtained from a saccharine solution, the changes are more complicated; the cane-sugar is converted into grape-sugar, the grape-sugar into alcohol, and the alcohol into vinegar. Thus the vinegar plant appears to perform the double function of first alcoholizing and then acetifying the solution. Do the yeast-like cells accomplish one portion of this task, and the bacterium bodies the other?

The mycoderm of wine does not in its ordinary state give rise to vinegar. Its own vital processes merely supply the means by which the changes incidental to vinous fermentation take place, but it occasionally happens that brewers are greatly teased by the acetous fermentation of their beer occuring after the alcoholic change has finished. I have heard of several instances this summer in which great annoyance has been experienced from this cause, and it would seem either that spores of the vinegar plant were diffused to a greater extent than usual, or that portions of yeast remaining in the beer had developed into the vinegar plant form. M. Pasteur's view of fermentation does not coincide with the common statement that the yeast plant merely separates sugar into carbonic acid and alcohol—at any rate he does not represent that as the entire process, because he tells us that when experiments were performed in close vessels containing, besides the fermenting liquid, a known quantity of air, it was found that the vinegar plant took oxygen from the air, and therewith converted the

* *Miller's Chemistry*, vol. ii. p. 185.

alcohol into acetic acid, and that the mycoderm of wine converted the alcohol into water and carbonic acid. Thus both act as oxydisers, and it is well known that if the vinegar plant be left in a fluid after it has transformed the sugar or alcohol into vinegar, it then burns up the vinegar, and leaves the housewife, or other manufacturer, who has neglected to remove it at the right period, only dirty water for her pains. M. Pasteur also tells us that the vinegar plant cannot acetify when it is submerged, while, as the German *unterhefe* yeast proves, the wine or beer fermentation can be excited by a yeast plant at the bottom of the fluid. These facts suggest inquiries into the action of different portions of a thick vinegar plant, of which one part is always under the fluid.

It seems to the writer that Professor Graham's researches into dialysis afford a probable explanation of the actions of small plant cells in the cases adduced. Their delicate membranes give a preferential passage to one substance over another, and they may permit new combinations to be formed by allowing them the means of getting out of the way of those from which they were derived. They present oxygen to a compound, and if certain of its atoms choose to take it, they can escape with the new object of their chemical attachment. Thus the process bears some resemblance to the decompositions effected in water when that fluid allows the new resulting compound to fall as a precipitate, or escape as a gas.

M. Béchamp states that acetic acid is one of the products of vinous fermentation, and the fact is accepted by M. Pasteur. M. Maumené disputed it, declaring that all well-made wines contained no acetic acid. This brought a rejoinder from M. Béchamp, to the effect that acetic acid is found even in the must of grapes. M. de Luca examined sixty-seven wines of Tuscany, and found acetic acid in all. M. Pasteur found that if a small quantity of vinegar was introduced when the *Mycoderma vini* was growing in an alcoholic liquid in contact with air, it disappeared, and he never obtained acetic acid from the growth of that plant in a liquid of this kind. These facts seem to show that the vinegar plant is present in all alcoholic fermentations, and exerts *some* action, although the chief and prevailing action is that of the *Mycoderma vini*, which is antagonistic to it, notwithstanding its analogous character.

Here I leave the question for the present. I have brought forward certain facts which I think important, and many conjectures which may stimulate inquiry, if they are not of any other use. The subject is within the reach of thousands of microscopists who habitually read the INTELLECTUAL OBSERVER; and I shall be much obliged if any of them will favour me with any new information they may collect.

THE DICRANUMS, OR FORK-MOSSES.

BY M. G. CAMPBELL.

About thirty species of Fork-moss are ascertained to be natives of the British isles. These, by strongly marked distinctions of foliage, naturally divide themselves into two groups, with the generic appellations of Dicranum and Fissidens.

As six of the Dicranums are in fruit during the month of November, we will confine our attention to them for the present. They are named from *δίκρανον*, a forked instrument, in allusion to the cloven teeth of the genus, and are perennial plants, growing on rocks or on the ground, sometimes on the trunks of trees, in tufts more or less dense and extensive; the stems varying in height from a few lines to several inches; the smaller species not much unlike the Weissiæ; the larger, among which are some scarcely surpassed in size by any other of the acrocarpous division of mosses, in some instances bear considerable resemblance to the *Trichostoma* and *Cynodontium*. The leaves are usually somewhat lanceolate, spreading, or secund, *i.e.*, all turned to one side, the reticulation variable, usually small, dot-like or roundish in the narrower part of the leaf, elongated, narrow, and often wavy lower down, at the marginal base considerably enlarged, quadrate, and tinged with colour more or less deeply. The calyptra cucullate, with a long beak; the lid conical at the base, with a long beak, slender oblique, and varying in length. The peristome single, consisting of sixteen equi-distant teeth, which are confluent at the base, and cloven half way or more into two unequal portions, the medial line being continued to the base with occasional perforations. They are also marked with transverse bars, prominent on the inside of the tooth, and surrounded externally with a somewhat rigid membrane of a red or orange colour. The spores are rather small and of a reddish brown tint.

The most commonly met with is *Dicranum heteromallum*, or the Silky-leaved Fork-moss. It grows in extensive silky patches upon moist banks, the stems tufted, or matted together, simple or branched, with crowded secund leaves, somewhat bristle-shaped and slightly dentate at the apex, of a silky appearance and with a flattened nerve, which forms the chief part of the upper portion of the leaf, giving

it the bristly appearance, and passing insensibly into the broader laminar substance of which the lower part of the leaf is composed. The capsule is cernuous, or sometimes sub-erect, obovate, gibbous, uniformly coloured of a reddish brown, with a somewhat, but never distinctly, strumose neck; the lid conical at the base, and tapering into a long beak, sometimes, but not always, with the reaping-hook-like curvature towards the extremity, as given in the illustration, which is a magnified representation of a specimen gathered from Ferny Hills, Nailsworth, where it seems to grow much more diminutively than in most other places, the usual height assigned to this moss being about an inch, while the specimens from Ferny Hills do not reach one-fourth of that measurement. The seta or fruit-stalk is slender, of a pale yellowish colour, and rather long in proportion to the plant. When dry and empty the capsule is slightly and obliquely furrowed, by which character and by the pale seta Wilson says it may always be distinguished.

In *Dicranum pellucidum*, or the Transparent Fork-moss, the leaves instead of being secund are squarrose, and variously bent. In form they are lanceolate from a slightly sheathing base, rather obtuse, entire, serrated or crenulate at the apex only, papillose on both sides, especially at the back and along the nerve, slightly undulated in the margin, keeled, and twisted or crisped when dry; and as *D. heteromallum* is found in patches of a deep, though bright green, *D. pellucidum* on the contrary grows in patches of a light green colour, from one to two inches high. The capsule is seated on a rather thick and wavy pale fruit-stalk; it is usually sub-cernuous, but in one variety erect, always roundish, shortly ovate or oblong, with thick firm walls of a reddish brown, becoming at length blackish, and destitute of a struma. The teeth of the peristome are variable both in form and markings, sometimes but very slightly cloven, and sometimes with prominent bars. The lid is large, conical at the base, with a longer or shorter oblique beak, always much thicker than in *heteromallum*.

D. pellucidum grows on wet rocks and stones in shady rivulets, and loves the spray of cascades.

Dicranum Schreberi, or Schreber's Fork-moss, grows also in light green patches, but the stems are only from half an inch to one inch in height. It is also found by rivulets or ditches, on sandy or clayey soil, but is regarded as rare. The inflorescence of all three is dioicus, the barren flower being terminal on a separate individual.

The leaves of *D. Schreberi* are widely spreading, and flexuose; from a broad sheating base they suddenly contract into a narrowly lanceolate, or lanceolato-subulate form, denticulate in the margin near the apex, with a nerve ceasing below the

point. When dry they become slightly crisped. The perichætial are larger than the others. The capsule, like that of *heteromallum*, is cernuous or sub-erect, but in form it differs in being shortly ovate, regular or slightly curved, and having a large lid but shortly rostrate, about as long as the capsule.

Dicranum crispum, or the Curl-leaved Fork-moss, is found in incoherent patches of a green colour; the stems not half an inch high, and scarcely branched. It grows on moist banks in a sandy soil, but is not common. The leaves are not much crowded, widely spreading, wavy and subulate, with a suddenly dilated sheathing base, somewhat glossy and minutely denticulate, the nerve forming the principal portion of the upper parts of the leaf. When dry the leaves are crisped. The capsule is borne erect on a reddish fruit-stalk, ovate or ovate-oblong, not strumose, but having an annulus, and furrowed when dry; the lid is conical at the base, as in the rest of the genus, with an oblique awl-shaped beak. The plant is sufficiently distinguished from its allies by the very narrow crisped leaves and erect striated capsule. The inflorescence is monoicus; the barren flower shaped like a small bud.

In the variable Fork-moss, *Dicranum varium*, the inflorescence is dioicus, the stems short, cespitose, or loosely aggregate, of a rufous green colour, scarcely half an inch long. The leaves are more or less secund, lanceolate, carinate, and entire or slightly toothed at the apex, the margin reflexed, nerve sub-excurrent, the perichætial leaves scarcely sheathing, and hardly differing from the rest. The capsule varies from ovate to oblong, more or less oblique and incurved, slightly tumid at the base, its walls thick and smooth. The fruit-stalk twists to the right; the lid is large, with a short beak. The peristome is large, deeply cleft, and of a deep red colour, the teeth converging. No annulus, and the barren flowered plants are more slender than the fertile ones. Soil and locality make considerable difference in this, one of the commonest species of the genus. Habitat, moist banks.

D. rufescens, or Reddish Fork-moss, has also a dioicous inflorescence, with short gregarious stems scarcely branched, sub-erect, bright red; leaves almost pellucid, lax, secund, reddish, linear lanceolate, with plane margins, obscurely toothed and loosely cellular. The capsule is erect, smooth ovate, reddish, with a short neck; the lid large, with a short beak; the fruit-stalk twisted to the left. The teeth of the peristome are more closely barred than in *D. varium*, and it is altogether a more elegant moss; this circumstance, joined to its colour, at once distinguishing it, though found in similar spots. All the above species are found in fruit during this month, and it is hoped the above descriptions will suffice to render them easily distinguishable.

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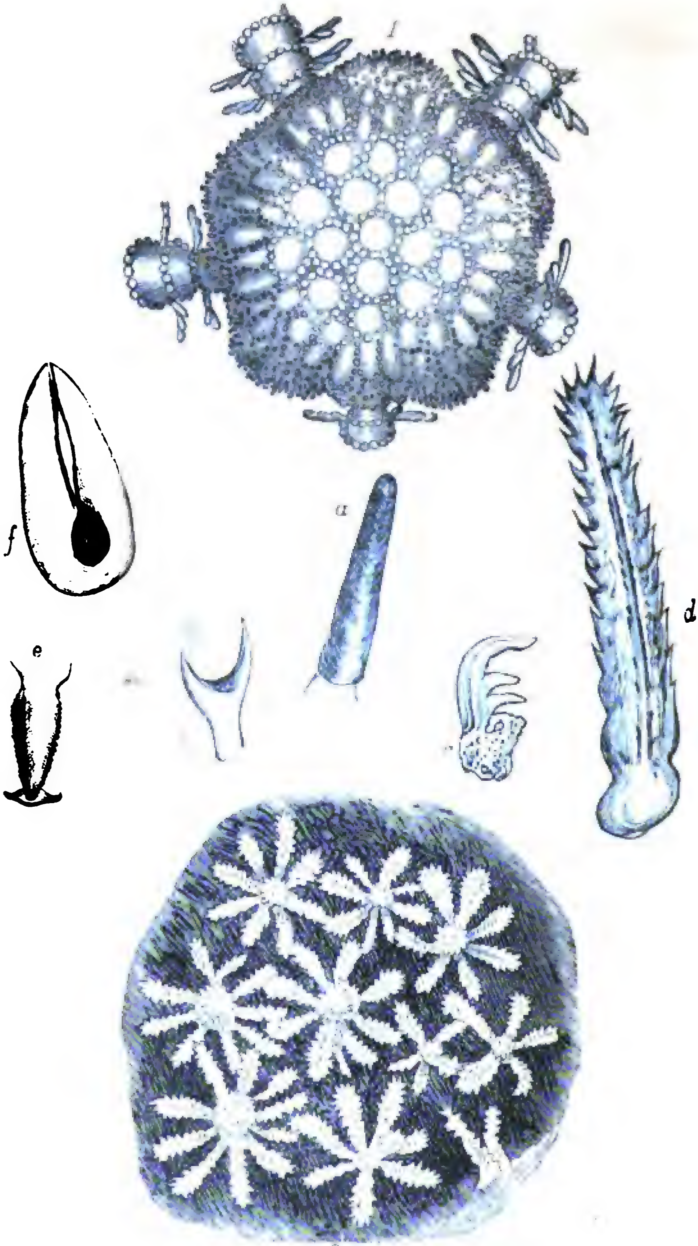


1. Disk of Ophiocoma bellis (magnified.)

2. Part of ray of Luidia fragilissima (magnified.)

THE BRITISH STAR-FISHES.

BY GEORGE S. BRADY, M.R.C.S.

(*With a Tinted Plate.*)

It is not at all the object of the present paper to give any general account of the natural history of the Star-fishes, but simply to notice a few points in their structure and economy which may be interesting to the general reader, and especially to the microscopist. And to be easily intelligible we must first briefly describe the external structure and configuration of the creatures to which we refer.

The sub-kingdom Radiata of the older naturalists is now, in accordance with the results of recent investigation, broken up and reconstituted. The fundamental idea of a radiated structure was, however, so far as mere external appearance went, correct enough, and no better type of such an organization could be desired than that supplied by the common Star-fishes. Each Star-fish consists of a central disk, from which are given off symmetrically, like the spokes of a wheel, the arms, or to speak technically, the rays. These rays are mostly five in number, but in some species seven, twelve, or thirteen may be observed. The common Sun-star (*Solaster papposa*), one of the largest and handsomest, as well as one of the most common species, has usually thirteen rays; while the still commoner *Urasters*, found everywhere between tide-marks, are examples of the five-rayed form. The number *five* is, so to speak, the key-note of the class Echinodermata, and may be found in all parts of their external organization, continually recurring either singly or in multiples.

The under surface of a Star-fish exhibits a central orifice, which acts both as mouth and anus; and diverging from it on the under surface of each ray is a longitudinal space or "avenue," furnished on each side (except in the *Ophiuradæ*, Sand-stars and Brittle-stars, where moveable spines take the place of suckers, and in which the "avenues" are absent) with innumerable retractile suckers or feet, which serve as organs of locomotion. The Star-fishes are divided according to their mode of locomotion into Spinigrades, moving by means of spines—Cirrhigrades, by suckers—and Pinnigrade, by fins or pinnæ. Of the last-named division we have only one British genus, *Comatula*, concerning which some remarks will be found toward the end of this paper. At the very extremity of each ray is an organ like an eye, having spinous appendages, which are termed the eyelids. It is doubtful, however, whether these parts have really any visual endowment; no proof of their possessing the faculty of sight has ever been advanced, and from

what we know of the nature of this sense generally in the lowest forms of animal life we should be disposed to consider that the organs in question must serve some other as yet unknown purpose. Other animals not far from the Star-fishes in general organization, though possessing, so far as we know, no special visual apparatus, are yet extremely sensitive to light, and this sensitiveness seems to consist of a nervous irritability shared by every part of the body, higher in degree, but possibly of a nature somewhat analogous to that of similar manifestations observable in plants.

The upper or dorsal surface of the Star-fish presents appearances differing very considerably in different genera. It may be perfectly smooth; it may be rough with tubercles or bristling with spines, and it is the various forms of these appendages to which we wish at present specially to devote our attention. The genera *Ophiura* and *Ophiocoma* (Sand-stars and Brittle-stars) may be easily recognized by the great length and tenuity of their rays, and their excessive fragility. The whole surface, both of disk and rays, is covered by scales which are so closely appressed as to give an almost perfectly smooth surface. These scales are arranged in definite and often in very beautiful patterns, and in some species the primary scales are edged or encircled by series of circular bosses or tubercles, giving an exquisitely "rosulated" aspect to the disk and rays. An example of this is given in Fig. 1 of the tinted plate, which is a representation of the disk and bases of the rays of *Ophiocoma bellis*. Though the surface of the disk is in mature individuals of these genera mostly smooth, many of them are when young closely beset with spines, and in some cases these are persistent even in mature age. The disk of *Ophiocoma Goodsiri* is not unfrequently thus clothed. Its spines are represented at *a* in the tinted plate; *b* of the same plate illustrates the spines, which cover the disk of young *Ophiocoma rosula*. The rays are in these genera constantly provided with numerous spines which serve as locomotive organs, differing, however, very widely in length and strength. *Ophiocoma filiformis* has its spines frequently tipped with curious anchor-shaped processes (fig. *e*), which are supposed to facilitate the motion of the creature over the muddy bottoms which it frequents. In *Ophiura* they are very short, and not apparent without careful inspection; while in *Ophiocoma* they are so long as to give quite a bristly, spinous appearance to the animal, being sometimes, in fact, very much longer than the breadth of the rays. The gradual development of the spines of *O. rosula* has been carefully studied by Mr. Hodge.* In their early stages they are armed with hooks at the extre-

* *Transactions of Tyneside Naturalists Field Club*, vol. v., p. 41.

mities, but by successive deposits of calcareous matter at the base of the spine, the hooks are constantly pushed forwards and finally obliterated. They are, however, occasionally observed in mature specimens, and in cases where a rejected limb is in process of reconstruction. Fig. *c* in the woodcut is copied from Mr. Hodge's illustration of the "hooks" of young *Ophiocoma rosula*, and Fig. *d* represents one of the spines of an adult specimen. The common "Cross-fishes" (*Uraster*) of our coast have a reticulated surface, set with lines of short, but sharp spines: these differ in length and strength according to species. In *Uraster glacialis* they are very strong, and arranged in well marked ridges. In this genus are constantly noticed the peculiar appendages termed *Pedicellariæ*, of which we shall have more to say further on. *Cribella* has a non-reticulated surface, but in lieu of the network and spines is covered with small tubercles mostly irregularly arranged. About these there is not much to interest the microscopist.

Among the largest and handsomest of British star-fishes is *Goniaster equestris*, the Sea-pincushion, as it is called by our northern fishermen. The appellation is not inapt, for the large fleshy mass of the animal is covered thickly with round bosses or tubercles of the size of a large pin's head. Each of these is encircled at the base by a series of smaller tubercles, generally from twenty to thirty in number. Interspersed among the tubercles over the whole upper surface, but still more numerously beneath, are certain pincer-like organs, composed each of two flattened lips or valves, which fit together accurately, and which during the life of the animal may be seen in constant motion, opening and shutting, so at least say the fishermen. I have never myself seen the creature alive. I do not, however, doubt the fact. Dr. Johnston states that the radiating circles of spines of *Luidia* (described further on) have the power of voluntarily opening and closing in a similar manner; and he also noticed the same phenomenon in the present species. These pincers are likewise surrounded by circles of small tubercles. The pentangular disk and rays are bordered by a double row of flattened plates, each of which bears three or four large tubercles, and is encircled by a series of minute ones in the same way as the simple tubercle of the disk. The elaborate ornamentation and great size of this species make it a very desirable addition to the cabinet. It is often brought in in considerable numbers by the trawlers on our north-eastern coast, and specimens not unfrequently measure ten or eleven inches in diameter.

A striking contrast to this large and fleshy species is *Palmipes membranaceus*, the "Bird's-foot Sea-star," which is almost as thin as parchment, and might, as Professor Forbes

says, be readily mistaken for the torn-off skin of some bulkier species. Its surface is covered with slightly elevated tubercles, which bear very closely-set fasciculi of short and sharp spines. It is one of the rarest of our native forms, being altogether an inhabitant of deep water, and is mostly found very much denuded of its spines.

Asterias aurantiaca and *Luidia fragilissima** present a surface structure very different from any of the species previously noticed, their tuberculated epidermis being so closely set with upright spines, as to be almost wholly invisible. These spines are arranged in a radiated or rosette-shaped manner, and have a roughened surface. A portion of the ray of *Luidia* forms a microscopic object of exquisite beauty: it is represented in Fig. 2 of the tinted plate. The excessive fragility which characterizes many star-fishes is in no instance better shown than in *Luidia*. Forbes gives the following graphic account of the capture of one of them, probably off the coast of the Isle of Man:—"It is the wonderful power which the *Luidia* possesses, not merely of casting away its arms entire, but of breaking them voluntarily into little pieces with great rapidity, which approximates it to the *Ophiuræ*. This faculty renders the preservation of a perfect specimen a very difficult matter. The first time I ever took one of these creatures, I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment I found only an assemblage of rejected members. My conservative endeavours were all neutralized by its destructive exertions, and it is now badly represented in my cabinet by an armless disk and a diskless arm. Next time I went to dredge on the same spot, determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which article star-fishes have a great antipathy. As I expected, a *Luidia* came up in the dredge, a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sunk my bucket to a level with the dredge's mouth, and proceeded in the most gentle manner to introduce *Luidia* to the purer element. Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not, but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In

* *Luidia fragilissima*, Forbes, is now sub-divided into two species, *L. Sarsii* and *L. Savignii*, the one having five and the other seven rays. The two species, however, present no structural differences.

despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision." It may be added, that even had the Professor succeeded in "introducing *Luidia* to the purer element," it is very probable that his expectation of procuring a perfect cabinet specimen would not have been realized, for fresh water, though it mostly seems to paralyze and kill star-fishes instantaneously, thus preventing their breaking up, does not act so favourably on *Luidia.* The creature may be put at once into cold fresh water, and will lie there for some time breaking itself to pieces. The only way in which (so far as I know) this can be avoided is to press the disk of the animal forcibly down with the hand until it is dead. In this way its destructive contractions may be prevented.

The cirrhigrade star-fishes are furnished with certain curious appendages, the use of which is at present very imperfectly understood. These are the "*pedicellariæ*" and "*madreporiform tubercle.*" The latter is a rounded, cushion-like eminence of considerable size, situated on the disk, mostly very much out of the centre. It is irregularly fissured in a radiate manner, and is not at all unlike the animal from which it derives its name. It is found to communicate beneath with a short canal, which is connected with the vascular system of the star-fish. Various conjectures have been made as to the use of the madreporiform tubercle. It has been supposed to act either as a secreting organ for the calcareous elements of the animal, or to filter out the impurities of the circulating fluid. Professor Forbes looks upon it as being merely the analogue of the stalk which exists in the young condition of the crinoid star-fishes: if this be really the case it must be considered as a rudimentary organ without any specific function. The *pedicellariæ* are pincer-like organs which are irregularly scattered over the surface of the animal, and which have distinct characters in the different species. They were for long supposed to be parasitic creatures, but are now generally admitted to be true epidermic appendages. They are in constant active motion during the life of the star-fish, and grasp firmly anything which is brought between their blades.* Their nearest analogues are the birds'-head processes which occur in certain zoophytes, and which Mr. Gosse believes to serve the purpose of seizing organic matters, and by holding them in their grasp to provide food for the animal in an indirect manner; for the decomposition of the captured morsel in time attracts round it clouds of infusoriæ, which are swept into the stomach of the polyp by its vigorous ciliary action. It is needless to say, that although

* One of the pedicellariæ of *Uraster rubens* is shown at *f*, in the woodcut.

the pedicellariæ of Echinoderms are somewhat similar in appearance, they cannot be supposed to perform a like office in animals so well endowed with locomotive powers, and so voracious in their attacks upon creatures almost as large as themselves, such as oysters and other molluscs. Star-fishes are, indeed, held to be the most destructive enemies of oyster-beds.

We must not conclude our paper without some notice of the Feather-star (*Comatula rosacea*), perhaps the most interesting of British star-fishes—one which is unique in the gracefulness of its form and the exquisite beauty of its colouring, whose life-history is very remarkable, and which possesses the additional interest of being the only living representative in our seas of the group of organisms so familiar to us in the fossil state as *Encrinites*. The delicate structure of this species renders it impossible to preserve it satisfactorily in a dry state: it is only when exhibited in some preservative fluid that any idea can be formed of the elegance of the living animal. The central cup-shaped body gives origin to five rays, which divide so near the base as to appear like ten. These are furnished throughout their length with membranous pinnæ or fins, with which the creature swims freely. It is said to propel itself somewhat in the manner of a medusa, using its arms alternately, five of them being in action while the other five are quiescent.

In the year 1823, Mr. J. Vaughan Thompson (whose name will be held in lasting remembrance as the discoverer likewise of the metamorphoses of the Crustacea), found in the Cove of Cork a creature about three-quarters of an inch in height, resembling very much a minute feather-star set upon a flexible, articulated stem. This he described and named *Pentacrinus Europæus;* but in 1836 he published a second paper in which he announced his discovery that the *Pentacrinus* was but the young state of *Comatula,* and this opinion is now held by all zoologists. Mr. Thompson found all his *Pentacrini* attached to Zoophytes, but they have been taken by others amongst Fuci, though never upon stones or shells. The larger *Comatulæ* are mostly met with in deep water, being taken by the dredge; and it would appear that they come into the shallower water near shore for the purpose of depositing their ova in the littoral groves of Zoophytes and Laminariæ. The development of the animal from the ovum, through the pentacrinoid stage to the mature form of Comatula, has never, I believe, been watched uninterruptedly: the feather-star has not yet been caught in the very act of leaving its encrinital stem, but for all that, the facts which *have* been observed, though they rather invite than preclude further investigation, are amply sufficient to place this most interesting episode of animal life beyond the doubt of any but the most inveterate sceptic.

CLUSTERS AND NEBULÆ. OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

The lover of system may perhaps have felt disposed to take exception to the arrangement of our little catalogue of Double Stars, and with some justice, from his point of view. Large and small, close and wide, conspicuous and difficult, were all intermingled in the greatest apparent disorder. This, however, was deliberately done, on the ground of the observer's convenience; the intention not having been to provide a classified catalogue, but a familiar guide to the amateur through each successive month. A similar apology, or, at any rate, explanation, is even more requisite at the commencement of our present list, since the objects we shall enumerate are yet more dissimilar from each other, and will be arranged in a manner still more unlike systematic classification. The difference is extreme between a coarse group of bright stars visible even to the unaided eye, and a faint and almost evanescent haze, whose stellar nature depends upon inference alone, or possibly may be liable to suspicion. The reader, however, will find them all here, arranged merely to suit his convenience: and possibly he may not be displeased with the resulting effect of variety and contrast. It should also be borne in mind that though the comprehensive title "Clusters and Nebulæ" is more appropriate than either designation would have been separately, it indicates in many cases a distinction without a difference; nearly all clusters that are visible at all with the naked eye appearing to it as nebulæ, and an increasing proportion of telescopic nebulæ being resolved into clusters as we increase the aperture of our instruments. The boundary-line has an actual existence in every telescope, when it ceases to recognize individual points of light in the haze; but it is different in different instruments, and it has no existence in nature,—or at any rate the question of its existence is one of the most perplexing, as well as most interesting, points in modern astronomy,—and therefore any arrangement which pre-supposes a definite separation, must needs be, in the present state of our knowledge, merely arbitrary.

Our commencement will be a glorious one. We shall take up first an object, the very finest perhaps of its class in our latitudes—

I. *The Cluster in the Sword-hand of Perseus,* in astronomical symbolism 33 H vi., that is to say, No. 33 in Sir W. Herschel's list of "very compressed and rich clusters of stars," which form the sixth class in his celebrated catalogue. Being obvious to the naked eye as a nebulous spot of some extent, or rather, with 34 H vi., as two contiguous nebulæ, this will be

immediately found in the galaxy between *Cassiopea* and the principal stars of *Perseus* (see INTELLECTUAL OBSERVER, xi. 373). Even small telescopes will here disclose a scene of wonder. Smyth has described it as a brilliant mass of stars, from 7th to 15th mags., filling the whole field of view, and emitting a peculiarly splendid light. In the centre, he says, is "a coronet, or rather ellipse, of small stars, above an 8th mag. one. . . . The 7th mag. star which follows is handsome from the blackness of the space immediately around it. . . . This is followed by another gorgeous group of stars from the 7th to the 15th mags. at about 3ᵐ, and nearly on the parallel. It is 34 H vi. The components gather most towards the centre, but there is little disposition to form; the sprinkle, however, is in a direction parallel to the equator. One of the central individuals is of a fine ruby colour, and a 7th mag. in the *n f* is of a pale garnet tint, with two sparkling but minute triplets south of it. These two clusters are quite distinct, though the outliers of each may be brought into the same field under rather high powers; and, on the best nights, the groups and light are truly admirable, affording together one of the most brilliant telescopic objects in the heavens. It is impossible to contemplate them and not infer that there are other laws of aggregation than those which obtain among the more scattered and insulated stars."

If these clusters are, as Sir W. Herschel thought, a protuberant part of the Milky Way, and if magnitude is not a wholly fallacious guide as to distance, the splendour of their components, as compared with the average minuteness of the individuals which make up the feeble light of the galaxy, would indicate that they must be very much nearer to us than the general situation of that zone, and that this region must consequently be the foreshortened projection of a long irregular stream of stars, whose direction is towards the spectator. The whole of this district is truly magnificent. Whoever would gain an extended idea of the infinite riches of the Creator's handiwork, may find it in sweeping over this, as well as many other portions of the galaxy, where He has literally

"Sowed with stars the heaven thick as a field."

Our second object will be one of an entirely different character; less brilliant, indeed, but mysterious in the highest degree:—

II. *The Great Nebula in Orion.* Beneath the lowest, or most easterly of the three gems of Orion's belt, we see a depending line of smaller stars, forming the *sword,** one among

* In 1807, the University of Leipzig formed a new constellation out of the belt and sword of Orion, to be called by the name of *Napoleon*. What a melancholy, but instructive, instance of human weakness!

which, having a more hazy aspect than the rest, will be recognized at once as a nebula by the naked eye in a clear night. It is singular, therefore, that it should not have been included among the "nebulosæ" of the ancients; and still more singular that Galileo, in making the earliest telescopic delineation of this region of the sky, including the very stars in question, should have missed it; for small as his instrument was, it was abundantly adequate to disclose to him a marvellous appearance in the midst of them. We can only suppose that he may have mistaken it for the effect of moisture upon his eye-glass, but if so, his examination must have been a very cursory one: and this, indeed, we should deduce from the roughness of his sketch, unless, as is so frequently the case, engravers and copyists may have been in fault. The first notice of it which has been found is a correct though incidental description of it by Cysatus shortly after, who compared with it the telescopic aspect of the grand comet of 1618. Huygens, not being aware of this, announced it in 1656 as a discovery, the like of which he had not been able to observe anywhere else among the stars, and sketched it roughly with a power of 100 in his 23 feet refractor. His impression was that no telescopes but his would show it; a curious example of the amount of self-deception which may result from unchallenged success, for we cannot imagine that the object was less visible to the naked eye then than now. He saw, however, as it appears, only three of the stars in the trapezium, which forms so conspicuous a centre-piece; the 4th was added by Picart in 1673.* It was natural that so remarkable an object should attract much notice, and many descriptions and figures by the earlier astronomers are extant; but for want of optical power their results are of little value. Sir W. Herschel figured it in 1774; it was the first object viewed with his 40 feet reflector in 1787; and he gave another design in 1811: Schröter represented it in 1794; Sir J. Herschel in 1824, and again at a greater altitude and in a clearer sky at the Cape of Good Hope in 1837; and among other modern observers, the Earl of Rosse, Lamont, Lassell, Bond, Liapounov, Struve, and Secchi, have directed much attention to it. Notwithstanding the magnificent instrumental means and unquestioned ability brought to bear upon it by these great astronomers, their representations are not altogether accordant, and, generally speaking, they are not fully satisfied with each other's work. There must indeed be always a margin of uncertainty left as to these ill-defined and cloudy patches; and Sir J.

* Arago says, by Dominic Cassini; but without reference: and this seems improbable, as Mairan, who gives the exact date of Picart's discovery (March 20), makes no mention of Cassini's. Picart's observation remained, however, in MS. till 1731. Cassini died in 1712.

Herschel has cautioned us that "very great differences will occur in the descriptions of one and the same nebula taken on different nights, and under different atmospheric circumstances, as well as in different states of the mirror and the eye; nor will it at all startle one accustomed to the observation of nebulæ to see such an object described at one time as faint, small, round, and at another as bright, pretty large, pretty much extended, resolvable, etc.;" but after making every allowance on this score, as well as for the great difficulty of representing such an object well, it must be admitted that the variations are more considerable and perplexing than, considering the character of the observers, we might have expected.

Are we then thus forced upon the supposition of actual physical change? Such an idea would be sufficiently astonishing, when the enormous magnitude of so remote an object is considered; but it has been seriously entertained. Herschel I. had been led to suppose it fully established, from the disappearance of a misty envelope round certain stars adjacent to the nebula, and from an alteration in the direction of one of its branches; and though his son had at one time come to the conclusion that there were no differences which would not admit of explanation upon the grounds already mentioned, and that there was no reliable evidence of change, he subsequently felt obliged to alter his opinion, from the dissimilarity between his own designs in England and at the Cape; other discrepancies he could account for, from practice and a superior instrument and climate; but as to one part, he says, "it seems hardly possible to avoid the conclusion of some sensible alteration having taken place. No observer now, I think, looking ever so cursorily at this point of detail, would represent the broken, curved, and unsymmetrical nebula in question . . . as it is represented in the earlier of the two figures; and to suppose it *seen* as in 1837, and yet *drawn* as in 1824, would argue more negligence than I can believe myself fairly chargeable with." This would be indeed most weighty testimony, even if it stood alone; but such is by no means the case. In 1852, Lassell, after observing the nebula carefully with his 24-inch speculum, says, "a comparison of Sir J. Herschel's, Mr. Bond's, and my own drawings of this wonderful object must, I think, suggest the idea of change in the nebula, or variability in the stars, or otherwise a less uniformity of delineation of the same things than might have been hoped for." In 1856 W. Struve was led by the observations of Liapounov, who had during four years been most scrupulously measuring and delineating the nebula at Kazan with a 9½-inch achromatic, to infer that it may be subject to changes of form and relative brightness in its different

parts. The year following, a very minute and continuous examination of the central portion with the great achromatic at Poulkova induced O. Struve to entertain the impression that the light of its several parts was in a state of perpetual change. Even with the best definition, he says that its appearances were to him on no evening entirely agreeing with those on the next or any other night, and he points out several spots as open to the greatest amount of suspicion, adding, however, unfortunately we fear for our readers, that for the greater part such changes in the gradation of light can only be seen with very high optical means, and would require as much as ten inches of aperture, unless in extraordinary states of the atmosphere. D'Arrest, the Copenhagen observer, who is paying especial attention to the subject of nebulæ, and in a manner which promises most satisfactory results, thought, in May 1862, that these variations, especially the bridging over of the large dark opening with a misty filament, were the first established facts with regard to the variability of nebulæ.

But should any of these suspected changes be deemed sufficiently ascertained, we see at once on what a marvellous field of speculation we have entered. Hitherto we have been assuming that all nebulous appearances are, what the majority unquestionably are, nothing but the light of excessively remote and closely compacted masses of stars. But greatly as our power of belief has been enlarged by the study of sidereal wonders, it still remains inconceivable that any aggregation of stars could possibly experience such changes either of form or brightness as we should thus be compelled to admit. We cannot imagine a multitude of suns thus displaced collectively through distances, which upon any reasonable computation must be of enormous extent; no known force exists to which such a result could be ascribed; and the idea of simultaneous variation of light affecting uncounted individuals is equally inadmissible. Are we then sure that our original inference is in this instance correct? Is that misty brightness composed of stars at all? Is it not possible that it may be merely a luminous haze, as Halley had surmised long ago, of exceeding tenuity, and therefore capable of receiving impulses, which, however obscure their origin may be, would yet imply no such irreconcileable contradictions to all our experience? And have we not in comets, especially if they are conceived to be self-luminous (and the contrary has not been proved), an instance of a material exactly of such a nature? Ideas of this kind had gradually opened themselves to the mind of the great discoverer of the nebulæ and their starry composition, the elder Herschel; and in 1811 he announced this essential change in his earlier views. He had once supposed that even the most irresolvable or "milky" nebulæ

were all aggregations of stars of incalculable remoteness; but he had subsequently found bright stars so accurately centred in circular haze, that it was most improbable that the effect should be due to a mere perspective projection of the one upon the other; he had noticed other instances of nebulæ whose shape seemed remarkably accommodated to the position of stars, which must have been, it would seem, actually not optically adjacent; he had ascertained that the great nebulæ in Orion and Andromeda, brilliant enough to strike the unaided eye, and whose starry nature ought therefore to have been most apparent of all, were utterly irresolvable even in his gigantic telescopes; he had noticed in the former of these the combination of the brightest and the faintest nebulosity, and hence perceived that, contrary to all his former conclusions, "the range of the visibility of the diffused nebulous matter cannot be great;" and from an extended comparison of a series of circular irresolvable nebulæ, in the separate individuals of which central condensation and brilliancy gradually increased till it assumed a star-like character, he concluded that we thus had before our eyes at once the whole process by which a thin luminous haze is compressed into a flaming sun. This was the basis of the celebrated "Nebular Hypothesis," which in the hands of Laplace assumed such an extended development, and professed to account for not merely the creation of suns from self-luminous mists, but the formation of planets from rings of nebulous matter dropped off from these suns during the process of condensation, and of satellites in turn from the planets as they shrank into solidity. To some minds, speculations of this nature, however visionary, are so attractive that they become insensible to their attendant difficulties; others, on the contrary, incapable perhaps of originating such theories, are much more sensible of their weakness. However, the hypothesis in the present instance, as we have seen, was not without plausibility, and it seemed to rest on a substratum of something like fact, so long as the telescopes of Herschel I. were unrivalled in that light-grasping power which is so essential in these researches. But an appeal lay to the future; and the results of that appeal, while they have shaken rudely the foundation, have but introduced additional mystery. Schröter had suspected that his 18-inch speculum was beginning in some spots to approach the resolvability of the nebula; but his skill in this kind of observation was not great, if we may judge from the figure he has given. Herschel II. found it impracticable with a similar aperture in 1824. Lassell, with his magnificent 24-inch mirror, had no hope, in 1847, of the absolute resolution of even the principal part; and the purer skies of Malta, in 1852, and a power of 1018, did not enable him to break up the "wool-like

masses" in the slightest degree. But it was reserved for the Earl of Rosse, the constructor of the optical colossus of the age, to make known that in the spring of 1846 he "first perceived the brighter portions of the nebula of Orion in the neighbourhood of the trapezium breaking up into minute stars." It had been repeatedly examined with his 3-feet mirror in vain; but, according to the Herschelian maxim, that when an object has once been discovered, inferior instrumental means will show it afterwards, some of the individuals could be subsequently detected on very fine nights with that telescope also. Sir J. Herschel, in the superior air of the Cape, considered that its granular texture evidently indicated its starry nature. Bond, with his 14¾ inches of achromatic aperture, found that the components were "separately seen for a moment under favourable circumstances." Secchi, like De Vico before him, thought that the Cauchoix achromatic of 6⅓ inches showed twinklings and unequivocal signs of resolution in the clearest evenings (but those were Roman evenings), and, subsequently, with the 9½-inch Merz and a power of 1000, these bright points were more steadily seen. Now what are we to think of all this? or how are these seeming contradictions to be reconciled? Nothing seems to be absolutely demonstrated on either side; but admitting all the modern observations to be of equal weight, we may perhaps be drifting towards the supposition that the minute granulations into which those cloudy masses seem decomposable may not after all be stars, in the usual sense of the word; or that, as Secchi thinks, the brighter portions may consist of stars, while the fainter may be of another nature, and actually situated, as indeed Herschel I. had suspected, even nearer to us than some of the bright stars with which they seem connected. We may never be able to unveil the whole mystery, but it is reasonable to hope somewhat from the future. Larger telescopes are called into existence every year; and the result of Lassell's re-examination at Malta with his 4-feet speculum has not, it is believed, been made publicly known. He stated, in January 1862, that he saw so much more of its wonderful constitution as to feel the necessity of drawing it afresh; but his expressions, founded it is true upon a cursory view in not the most favourable circumstances, do not imply great hope of resolution; in fact he was "surprised, perhaps disappointed, not to see many more new stars." His final report will be received with the greatest interest.

The well-known trapezium has been already described as No. 93 of our list of Double Stars. The addition of the 5th star by W. Struve occasioned much surprise, the group having been so often studied before, through a long series of years, with telescopes fully competent to have shown it. Sir J. Herschel

is confident that it was not there when he made his first drawing in 1824, and re-examined it 1826, March 13, in a perfectly clear air, in company with Mr. Ramage, the celebrated maker of large specula. Nov. 11 of that year, Struve saw it in full moonshine: 1827, Nov. 16 and Dec. 16, Herschel found that it could not "be overlooked but by wilful inattention:" the following March he found that it had greatly diminished. It may very probably be variable, as Smyth supposes. As far back as 1664, only two years after the Royal Society had received its charter and its name, Hooke communicated to it that he had "found those stars in Orion's belt which M. de Zulichem" (*i.e.*, Huygens) "maketh but three, to be five." This seems vague; but as the original figure of Huygens shows only one group of three, the trapezium is probably meant; and if so, the 5th must then have been far more brilliant than at the date of any subsequent observation. At present, it forms a good test for object-glasses of moderate size; though less serviceable than if it attained a greater elevation. Dawes saw it with a 5-feet achromatic; but this gives little encouragement to ordinary eyes. I have repeatedly seen it with 5½ inches, lying a little outwards from the line joining the two *n p*, or fainter stars. The effect of 14¾ inches of light may be estimated from the fact that, though rated 13 mag., this little point has been seen by the American observers *after sunrise*. A more difficult object is a 6th, yet minuter star, discovered by Sir J. Herschel with Sir J. South's 11¾-inch object-glass, and considered by him to have only about ⅓ the light of the 5th. It lies, according to Dawes, but 2″·79 from the brightest, or most southerly, of the four old ones,* and consequently requires a superior instrument to be cleared from its rays. The remarkable fact pointed out by Sir J. Herschel, that "the apparent inequality of two stars seen at once in the same field of view diminishes as the light of the telescope is greater," and which, he justly adds, "ought to be always borne in mind when the comparative magnitude of stars is under discussion," is curiously illustrated in the case of these minute points, which Lassell found both equally bright and easily seen. He calls them even *brilliant!* Such was the light even of his old 2-feet speculum under the Maltese sky. Probably No. 6 may be variable, for Struve could never see it at Dorpat, and Secchi missed it on one occasion, though the atmosphere was beautiful; and yet Lassell had at one time thought it even larger than 5. Dumouchel and his successor De Vico added three more stars, but Sir J. Herschel could not find them, and the Cauchoix achromatic at Rome was known to have a bad habit of pointing out little *comites* that had no existence. Porro, however, the Paris

* Bond's drawing, by some oversight, makes the *f* star the largest of all.

optician, speaks of having seen two of them, and added a fresh one in 1857 with his enormous object-glass of 21¼ inches, about which such conflicting opinions have been expressed, and so little seems to be really known. This last may, perhaps, be the star discovered also by Lassell in 1862. It, appears, however, from the researches of Otto Struve, that other minute stars in this region show variable light; a circumstance, as he remarks, sufficiently singular in connection with their position in the central part of this wonderful nebula; and whatever fault may be justly found with Schröter's figure, on comparing it with those of Herschel and Bond, I am inclined to think that it points to the same conclusion. It has been noticed, as far back as Pond's day, that the interior of the trapezium is comparatively free from nebulous matter; and this does not seem to be a mere effect of contrast: on the other hand, an isolated star lying N. of the mouth of the great dark gulf was discovered by Mairan in 1731 to be encompassed by a haze, and has continued so ever since. The whole extent of the nebulous glow appears very considerable; much greater, from its undefined character, than might at first be supposed. By giving a rapid motion to his telescope, so as to induce the effect of contrast, Secchi has succeeded in tracing it through a space which may be described as roughly triangular, with a base of nearly 4° and a height of more than 5½°, reaching from its apex at ζ *Orionis,* with a break about σ, almost as far as υ; and a great part of this feeble light has been perceived by Goldschmidt with a little telescope of not much more than three inches aperture. A special investigation by the present director of Harvard University, the son of the late W. C. Bond, into the arrangement of the more luminous portion, has induced him to conclude that, notwithstanding its apparent confusion and real intricacy, it may be decomposed into a number of curved wisps or wreaths, of which he has distinctly traced about twenty, indicating a spiral structure, similar to that which the Earl of Rosse has detected in so many nebulæ, and which has been repeatedly found associated with a stellar constitution. Secchi also observed a spiral curve around one of the stars.

This summary of modern discoveries has extended itself to a length for which it is hoped that the exceeding interest of the subject may be a sufficient apology. It is to be regretted that the amount of optical power required for these researches is not likely to be at the disposal of many of our readers. They need not, however, be altogether discouraged. My comparatively small aperture shows sufficiently well the peculiar appearance which Lassell has described as masses of very light clouds, packed one behind another, their edges being very light and filmy, so that the sky is evidently seen through, or like little

thin carelessly-scattered masses of cotton-wool; and the only observation which I have had during the present season, and the first in which I have paid much attention to the nebulous light (October 6th, less than two hours before the remarkable earthquake), was a very satisfactory one, as I saw distinctly, with various powers, without previously knowing its situation, the "bridging over" of the *Sinus magnus*, or great dark opening, by a feeble filament, more distinct in the middle, with an occasional suspicion of a star there; and I even perceived, what at the time I had no idea had been previously noticed, that the portion of the gulf thus included was less dark than the interior, the reverse of what is shown by Bond, but, as I have since found, agreeing with the observations of Secchi.

OCCULTATIONS.

November 19, *κ Piscium*, 4½ mag., will disappear at 12h. 12m., and reappear at 13h. 9m. The observation will be favourable from the size of the star, and the approach of the dark limb of the moon, and unusually interesting from the occultation, only 4m. later, of 9 *Piscium*, a 6 mag. star. 30th. 60 *Cancri*, 6 mag., will be hidden from 10h. 33m. till 11h. 37m.

BOTANIZING AT OAKSHOTT HEATH.

BY SHIRLEY HIBBERD.

Oakshott Heath is almost a *terra incognita*. It has no place in "Bradshaw," and many of the folks who live within rifle-range of its black slopes and furze-fringed hollows have not yet inhaled its pleasant breezes. *Murray's Hand-book of Surrey* takes the tourist round its outmost borders, on the way to Walton, but keeps it all a secret that there is such a place as Oakshott, and of its name *Black's Guide* is equally silent. It is not at all strange that Oakshott should hide itself from public gaze, and keep its seclusion sacred among the shadowy pine woods, for it has attractions only for the lovers of scenery and the collectors of plants. There is no Hall with quaint carvings and old pictures—no village with Gothic or Norman church—no inhabitants even but stag-beetles and small, lean kine, which vanish at nightfall no one knows whither, and reappear at daybreak to browse on moss or rushes, for there is scarcely a blade of grass to be found over hundreds of acres. If you examine the map of Surrey, you will observe that there is a chain of hills stretching east and west from Rochester to Guildford, thence to Ash, then north to Bagshot; thence north-east to Egham, and again due east to Kingston. These hills mark out the prime parts of Surrey, and when London botanists and pleasure-seekers are at a

loss where to go next for fresh air, fine scenery, and the choicest examples of the British flora, let them select any town or village in this range of hills, and having made the transit thither by rail or road, they may be sure of finding pleasure if they care to seek it. But supposing the reader to have explored these hills throughout, he will probably know but little of Oakshott; he will have shot past it, or round it, somehow in his wanderings, and the better for him, for there is a happy experience in reserve—a real sensation; and if he takes Oakshott last instead of first, the Surrey hills will be dealt with fairly: but it would be unfair to go to Oakshott first, because after feasting on its beauties, many more famous spots on this range will be found very tame by comparison. While the map is spread out, it will be as well to mark out the site that now interests us. The Epsom branches of the South-Western and South-Eastern Railways terminate at Leatherhead, almost in the centre of the long range of the Surrey hills. A little to the south of Leatherhead, the land rises higher and higher towards Dorking, and on the nearest of the slopes is situated the princely estate of Claremont, of which Oakshott is but an unimportant waste, producing scarcely fodder enough to keep one donkey. We have been botanizing about Leatherhead and the surrounding hills occasionally during the past six months, but as our botanizing was mixed up with serious matters of business, we rarely got more than glimpses of the floral treasures that abound here, and determined to put business aside for a season, and pay court to Flora only. Self and friend took train on the 28th of September for Leatherhead: arrived at Leatherhead at dusk, walked along the new road to the right of the station, past Prince's Cover, direct to Oakshott. Here found at the "Brown Bear" inn a party of rustics, eighteen in number, prepared to eat a supper of boiled beef, roast mutton, and plum pudding. Joined this party, partook of the generous fare, made speeches, and next morning started early to the heath. If my reader intends to take the same route, the "Brown Bear" is to be recommended, not for any elegance of the bear itself, for it is a somewhat rugged animal, but because of its nearness to the scene of action, and the certainty of finding the heath from this starting-point. We start, provided with vasculum, basket, and provender, for we shall not enter a human habitation till nightfall. We are armed with knives, pocket-lenses, good temper, stout sticks, and waterproof boots, but anticipate no dangers but such as properly belong to steep hills and treacherous bogs.

We take the road, and our first halt is at a bend to the left, where, as the land falls directly before us, we have a grand view of the country to the north and east. Far across the hills lies Hampton Court, to the right of that Kingston, and further on

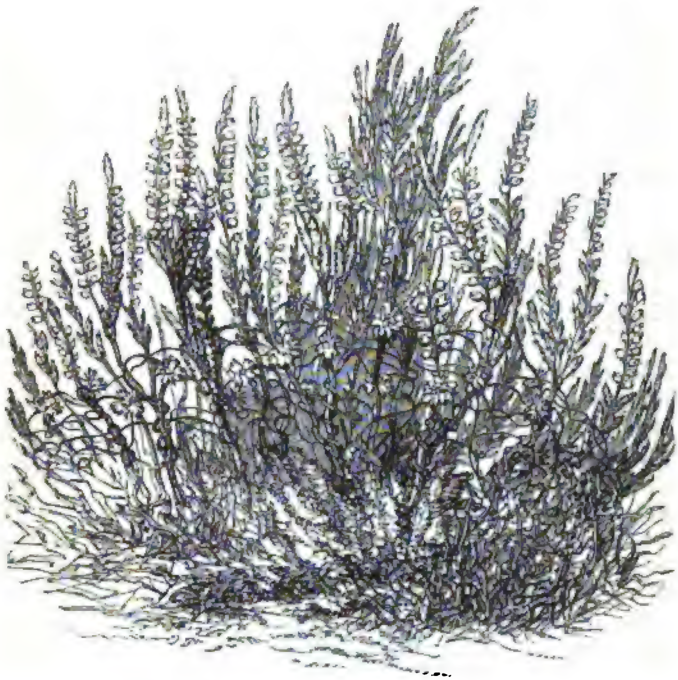
to the right rise the towers and nave of the Crystal Palace at Sydenham, a grand spectacle seen from this point, glittering in the morning sun. Here we make our first find, two feverfews, *Chrysanthemum parthenium* and *C. inodorum,* close together, smothered with fresh flowers, and smiling a welcome in the hedgerow. Immediately opposite is a steep bank, from the summit of which is obtained the best view of the country, and under that bank grow *Lastrea filix mas, oreopteris,* and *dilatata.* But we proceed on our journey, passing a grand cover, which is entered by a gate on the right hand, and where there is a wilderness of ferns and ericas that we dare not look at, or we shall never get to Oakshott. We now approach a landmark; it is a school-house on the right-hand side of the road, and here we turn off to the left into a quiet country lane. Friend avers that in a coppice to the left of this lane there are some grand specimens of fungi; so we commit trespass, cross a meadow, and are soon in the coppice, which at first sight appeared to be paved with pheasants. When these grand personages had made way for us, with a clatter of wings among the ash-poles like the first outbreak of a party of beaters in a wolf country, we found the place paved with ground ivy, violets, common species of veronica, geum, ajuga, primroses, and buttercups, most of them in bloom, and everywhere abundance of funguses. We bagged *Agaricus ceciliæ, A. rachodes, A. vaginatus,* the very beautiful *A. fusipes,* and a fine specimen which we could not determine, but apparently intermediate between *A. personatus* and *A. nudus.* It had a solid stem, but the pileus was brilliantly coloured. With the exception of the fungi we saw few plants here of any interest, and were soon on our way again back to the lane, and forward towards the heath. The banks in this lane are, however, worth examination. On one side the soil is dry and has plenty of sun, on the other side it is moist and shaded. On the sunny side there are half a dozen species of hawkweed and other gay composites, on the shady side common lastreas, grand festoons of bryony, and rich beards of chickweed smothering tufts of primula. The road presently bends to the right and we recognize one of the good botanical stations, here called "Wapping Dock," consisting of a bank and cover on the right hand, and a substantial farm-house and corn-ricks on the left. Here is the first proof that we are near the heath, for the soil of the bank is peaty, and on the bank there are a few stray tufts of ling and erica, and all the succulent and leafy plants looked starved. Here we found *Hieracium pilosella,* still showing bloom, and mostly smooth-leaved and stunted; *Apargia hispida,* the rough hawk-bit, starved down by drought and poor soil to a most delicate character, and claiming to be regarded as one of the most

elegant of alpines. *Apargia autumnalis* was here also in several forms, its gay yellow starry flowers sparkling like gold amid its tufts of dark green deeply-lobed leaves. *Senecio sylvaticus*, the mountain groundsel, and *S. tenuifolius*, the hoary ragwort, were scattered sparingly on this bank, and an unmistakeable tuft of emerald green proved to be the pretty *Sagina procumbens*, the properest of all plants except *Spergula saginoides* for fairies to dance upon. Wapping Dock opens in some sort of way, very mysteriously, on the heath. You have to wind about a sort of geographical corkscrew of lanes, banks, and bits of waste; but it is impossible to miss the way, for you have before you a prospect of pines flanking a broken waste as black as the shores of the Tyne in the neighbourhood of Newcastle. Of course we make our way in the direction of this uninviting scene, and presently forget its solemnity by tumbling into the midst of a wilderness of brake and blackberries. Nature is very kind to botanists. We see before us a savage wilderness, but we enter it by way of a lovely dell, where the brake rises like palms over our heads, the dwarf furze, *Ulex nanus*, is smothered with its golden flowers, and the blackberries present their sooty clusters, all glistening with ripeness, and we taste the sweets of civilization before encountering the bitters of solitude. There is a weird wildness in the scene we are entering upon; behind us are a few cottages and farms, before us miles of silent waste, populated to the extent of about one squirrel, one lean heifer, and one stag-beetle to the square mile. Rabbits and foxes appear to abound, for their burrows are plentiful; but as they are all in their subterranean retreats, they cannot count among the daylight population. But we are very pleasantly invited onward by the configuration of the country. Right before us lies a deep dry gully, forming the winter drain and boundary to a broad belt of pine and hornbeam that stretches away in front, and only ceases at the vanishing point in the landscape. From this gully the land rises rapidly to the right and carries the eye upward to the summit of a dark cone, almost as regularly formed as a sugar-loaf, but more obtuse in proportions. The sides of this gully would suffice us for more than one day's botanizing. The soil is white sand, deepening into black peat on the surface, and the vegetation is such as we find only in connection with sand, and peat, and pure air, and utter neglect by man. Nature has dressed these wilds in her own way, and now their principal decorations are huge and curious fungi. On every hand along the course of the gully and down in its dry bed, they are scattered with wonderful profusion. In some places you can scarcely step without crushing their flaky heads and pulpy stems, and here and there some monstrous Bovista or

Boletus has subsided in decay, and looks like a wet leather saddle or dilapidated knapsack. Here are lovely clusters of the little green-beaded and stripe-stemmed *Leotia lubrica,* the elegant dove-coloured *Dædalea quercinus* on fragments of dead wood, and an immense number of species of Agaric. But the grandest funguses here are *Boletus edulis,* which here grows to an immense size, and the brilliantly coloured and very poisonous *B. luridus,* with dark dull brown pileus, and vermilion and orange stem and tubes, the last presenting a most elegant reticulation when viewed through a pocket lens. We found also *B. luteus, B. versipellis,* and *B. scaber,* and one small specimen of *B. variegatus.* Presently afterwards, at a point where the fungi became less frequent, some grand clusters of *Agaricus longipes,* their broad shields supported on slender stems like lances, and at least half a dozen distinct degrees of grace amongst them, and a brilliantly coloured fungus which we took to be *Boletus purpureus.*

For the sake of a change we came up out of the gully, and encountered a herd of about twenty jet black pigs which had stealthily followed us from the village expressly to ascertain who we were, and what we were about. The leader, a splendid hog, promising to be fit for bacon at Christmas, advanced to very close quarters, made a few sniffs and gruntings, and then turned and led the herd back at a terrific gallop, satisfied we supposed with their scrutiny, and not a little alarmed at the ugliness of the people they had thus made acquaintance with. To tell the truth, we were almost as much frightened as the pigs, for when we went down into the gully there was not so much animal life anywhere visible or within hearing as would cover a sixpence; and after digging and shouting, and scrambling for half-an-hour, it was something of a surprise to come face to face with these negroes, all their moist snouts thrust forward, and the old baconer in advance, all eager to see and smell the botanists and the prizes. As the pigs scampered back, as if their tails had been singed, we trudged up the cone to make our first halt upon its summit. Now we began to feel we were on the heath; no more blackberries, brakes, or fungi; the whole extent of the hill side, and as far on all hands as could be seen, was a mingled mass of lichen, moss, dodder, and heath. Instead of walking on coal or flint, or any other hard or black material, the ground was almost snow white with lichen, which covered the entire surface from the base to the summit of the cone; through the lichen sprang ling and heath in such profusion that it was difficult to discover how the lichen could make so distinct a feature in the colouring, especially as much of the heath was still in bloom, and here and there made lovely sheets of rose, purple, and lively red.

We toiled on till we reached the summit, and there we sat down on the edge of a large saucer-like hollow of which the summit consists, and drank in the crisp breeze, and felt for the first time the grandeur of this solitude. And it is grand. The heathy slope looks as forbidding as the grave as you enter upon it, but changes to the luxuriance of a flowery cushion, into which the foot sinks deliciously, when it is reached; and after being shut in by the towering wall of Scotch pine on one hand, and the steep dark slopes of the heath upon the other,

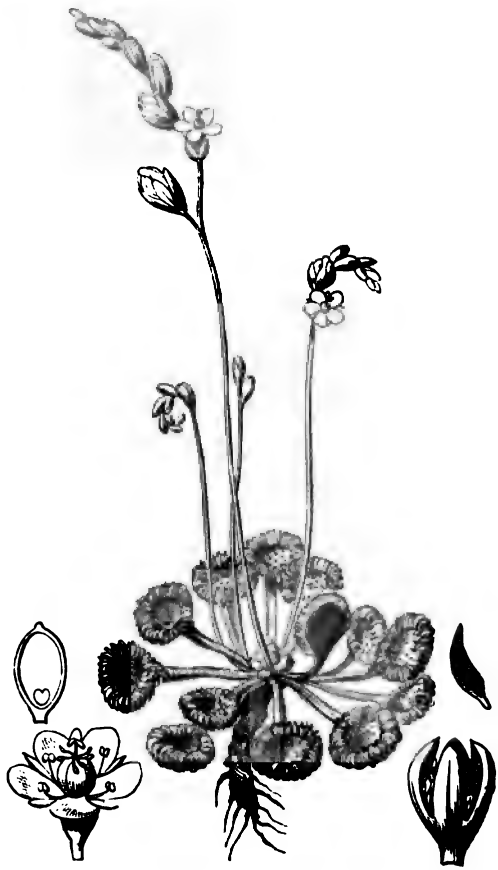


LICHEN, LING, AND DODDER.

the sudden expansion of the view on gaining the summit has an effect of that freshening and inspiriting kind that we feel on quitting a sick-room after a night's watching, to taste the breeze that comes with the rising sun, when the wild song of the thrush mingles with the delicious melody of the nightingale. Now there is much said about fine views, and I know a few of them. Friend knows a few also, but self and friend agree that the view from this cone is worth a journey of a hundred miles. On all sides there is a distinct boundary of green hills, forming an almost sharp circular basin, in the centre of

which, on a lesser hill, we stand and shout to the heath and the sky, and our admiration and our shouts are lost over such an expanse of open country that there is no echo. Below runs the dark line of firs, which leading onward to the wilds, seems interminable, and over their heads and through their few thin narrow gaps we catch sight of hills similar to those which skirt the horizon elsewhere. On the north, the fir woods darken into gigantic blotches, and seem at last to shrink away in the distance, as if in that direction they purposed to encompass the world. Eastward lies London, and we can just discern the cloudy canopy that overhangs it, as if it were blessed of heaven with a precious fall of dew, though we know but too well what that cloud is; it is the coal smoke that would kill all this lichen and heather in a week were it wafted across them as it hovers there to kill mankind instead. Now we can just catch sight of the towers of the Crystal Palace peeping over the line of a slight depression in the dark horizon, and as the eye travels towards the south, we see the lovely fir woods of Esher; then farther to the south the lands swell up richly and roundly, as if Dame Nature had bared her full bosom to the heavens to show that it still has the beauty of youth and the plenty of maturity. This grand swell drops down, and immediately another and a nearer hill rises, and where the slopes of the two approximate in the line of vision, their conjuncture forms a broad letter V on the horizon. That letter V gives the key to Box Hill, and from thence, as the eye travels towards the west, a glimpse of Guildford is obtained, and beyond that, when the atmosphere is clear, the view opens far into Hampshire, and little gray dots and indigo lines, and dust-like gleams of gray and brown, indicate the hamlets and woods and chalky hills of one of the loveliest counties of England. The air was balmy, the sun warm, and the barometer high when we started on our journey; here we found the air so bleak and the breeze so brisk, that one of the two had to light a pipe to ward off a twinge of tic, and when this was done we rolled about, and friend, the elder and more serious of the two, could only be brought back to botany by the question, "Does the dodder ever make roots in the earth?" Thereupon friend began to dig, and at last turned up a huge bunch of peat, lichen, ling, and dodder, and with great dexterity proceeded to anatomize the mass, the result being that a single thread of dodder might be traced almost any distance, round and round, in and out, up and down, and by a hundred true-lover's knots, through the wiry ling; it could never be traced to the earth, but it was frequently found to have thrust its suckers and formed clusters of those red bulbous points among the lichen, though no true root could be found. I can remember finding the roots of dodder twenty years ago, but that was early

in the season; and there is no doubt the root perishes as soon as the parasitic stems have got firm hold of furze, heath, clover, or any other plant on which it is wont to feed. Twice this season I went over parts of this same heath when the dodder was in bloom, and a marvellously lovely sight it was to see the ground surfaced with the lichen, then over that the crimson



THE SUN-DEW, DROSERA ROTUNDIFOLIA.

gauze of the dodder loaded with its minute but showy red blossoms; above that again the deep green and glowing crimson of the ling, and in every hollow the crimson sun-dew, in such profusion as to appear nearly as rich as the ling in its heyday. Now we found the same strange association of lichen, ling, and dodder, but the ling had parted with its full glory, the flowers

were for the most part withered and white, though there was still enough bloom to make many a dazzling patch and streak of colour. In one of our previous visits we had seen but not gathered the great dodder, *Cuscuta Europæa,* and we made a search for it now, but in vain; *C. epithymum* abounded on every hand, and in some places covered breadths of ground of more than a rod in extent so densely as to constitute a rich red matting, through which the ling struggled, and not in vain. It was like quitting a banquet after only smelling the viands, when we started once more on our journey; we felt we could not feast to our fill on this lovely spot, but a journey was resolved on and a journey must be made.

We retraced our steps towards the gully and followed its course, diverging from it only to return again. Met with *Juncus squarrosus* in all sorts of shapes, once mistook it for a tuft of spergula, and once for a tuft of *Festuca ovina,* but always determined it without trouble, for in all its states it carried fruit, and though position altered its appearance, it seemed to luxuriate equally in wet hollows as upon the driest of the sandy slopes. As we push along in the direction of the gully, we find we are entering an incipient pine-wood. First we meet with little seedling pines of a few inches high, next larger specimens, now a cluster, next larger isolated specimens, and next fine masses, crowding thickly and threatening to kill out those that are in the thickest of the mass. The ground is gradually acquiring a spongy character, rushes increase, and the heaths change their character, the dodder disappears, and so does the lichen. The ground gradually acquires a rich carpeting of verdure, sprinkled all over with the blossoms of the heath, and we discover that we are approaching what we may call the garden of Oakshott, a land of luxury as regards its floral products, but needing waterproof boots, for the dry gully has changed to a full watercourse, the hill to a hollow, and we are entering upon a vast bog, densely crowded with luxurious vegetation. We continue our course, still following the boundary of the Scotch firs, the seedlings of which are forming another forest on these wet parts of the heath, and at last we make our second halt beside a large black pool, which soddens the ground for a vast distance all around, and is visibly connected with extensive tracts of real bog beyond. Here we find ourselves surrounded with wonders and curiosities, which it would require weeks to explore effectively. Here is a little dark green gem with minute blue flowers. What is it? It proves to be *Polygala vulgaris,* the common milkwort. Next we discover masses of an apparently scrophulaceous plant, which proves to be *Scutellaria minor,* quite a gem among the trifles of the bog. Next we observe that wherever there is a

tolerably clear space of wet black earth, the bog pimpernel, *Anagallis tenella*, has covered it with its tiny horizontal stems and fresh green dot-like leaves; but it is out of flower, and we see only half its beauty. The next find is *Lycopodium inundatum*, in large tufts, deliciously green and in very luxurious condition. After placing a number of such things in the vasculum, and adding a few roots to the store in the basket for addition to our collection of living curiosities, we make a general survey of the scene, and are as much delighted with our feet reeking in the bog as an hour ago when we trod the dry sand and inhaled the bleak air upon the cone. The heaths have entirely changed their character, yet here are all the same species, *E. tetralix* with its lovely terminal umbels of soft rose-bells, *E. cinerea* with whorled racemes of purplish red, *E. vagans* with its crowded spikes of pink blossoms, and *Calluna vulgaris*, as fresh in bloom as in August, and of several shades of colour, from rich fiery crimson to deep dull purple. This was one distinct feature in the scene, the freshness of the flowers as compared with their comparatively faded condition on the dry bleak uplands. Next we observe that several spikes of pure white flowers were to be found on *E. tetralix* and *E. cinerea*, and then we discovered that we were not among a mere undergrowth of heath, for the plants had the character of specimens with distinct stems, freely branched and tree-like in all their characters. A specimen of ling measured three feet six inches in height, and specimens of two and a-half to three feet were plentiful on every hand, and these all in wet bog and deeply bedded among *Sphagnum*, *Lycopodium*, and innumerable mosses, lichens, and rushes. But there was yet another feature of this scene observable, and strange that we did not see that first. The rich colourings of the heaths were mingled with a general haze of deep orange, which we found to result from an immense profusion of blossom spikes—the blossoms now closed and the seed ripening—of the bog asphodel, *Narthecium ossifragum*, which after all is the prevailing weed here, and only escaped notice at first because it had passed its prime, and had ceased to glow with its bright shades of amber, orange, and gold. From this charming spot we departed reluctantly, with the vasculum and basket crowded, and our pockets wet with tufts of bog containing rooted plants which were to be taken home alive for culture in the garden.

Now we began to know something of the bog. The incipient wood thickened as we progressed along the boundary line, and we soon found that we were traversing the bed of a great boggy watercourse between two distinct forests, a sort of low channel, about 250 feet broad, consisting of a spongy surface of vegetation, chiefly rushes and aquatic grasses, and that at every

step we were in danger of being drawn in to make items in the fossils of the bog when it shall become rock, or coal, or lignite, or what else in the far-off ages. For those who make a similar tour in the course here indicated we give the word to beware at this point. There can be no mistake about the locality, because the watercourse has all the appearance of a road covered with rank vegetation, but not a tree or bush anywhere to check the progress of a horseman. By some means we got across this spongy dyke to the second or outer pine wood on the right, which is only a few inches higher than the bog. We had seen one squirrel while traversing the gully, now we heard the wind roar like a cataract of water in the old pine wood, and for the first time we became painfully conscious of the absolute deadness (as respects animal life) of this vast region. We had travelled miles, and had not seen one bird, we had neither heard nor seen a bee, a wasp, a cricket, or a blow-fly; we had long ago left the land of rabbits and foxes; here there appeared to be no game, no vermin, no *fera* of any kind; the wind, tumbling like water through the tops of the trees in the old pine wood, played the part of chorus, and a melancholy chorus it was. The only object of interest in the course of a journey of about a mile and a half beside this watercourse, was to find among the pines several pretty clumps of *Salix prostrata,* which clustered up with the grace and luxuriance of honeysuckle. We found here a sprig of *Betula,* with nearly circular serrated leaves, but could make nothing of it, and there were no birches about to claim it as kindred.

I like a genuine unmitigated gloom, the blacker the better—if a little dangerous and silent enough to cause a feeling of despair all the better; it prepares one to sympathize with our fellow-creatures who have been shipwrecked, shut up in coal-mines, or left helpless in a lighthouse without oil or fresh water or bread, and the sea running mountains high, and defying all help from the creature. Self and friend knew something of gloom, silence, damp, and danger ere we emerged from the wood, and once more basked in the sunlight, and breathed the free air, with the visible heaven above us. Oh, how delicious was it to spring forward on to a dry sandy slope again, and to make away across the thymy hummocks to a brook skirting a boundary line, and there make a feast of blackberries, so large, so black, so luscious, that if I trust myself to tell the truth, nobody will believe me; so let it suffice that this brook (which you can easily find if you follow in our footsteps) is arched over with huge rods of *Rubus fruticulosa,* and the fruit is probably not to be equalled by any other district of Britain. And what a brook this is! It is a paradise for a botanist. Think of lady-ferns being the prevailing weed of the place, and so luxuriant in

growth that you are puzzled for a moment to know *what* they are. *Lastrea oreopteris* showing its delicate visage through fringes of all the wild and delicate things that grow on damp banks, and amongst them *Equisetum telmateia* in the wildest luxuriance, ready to furnish any number of whipcords, umbrella frames, and skeletons of wigwams for the fairies, and very elegant and indescribable tufts of herbage for the conservatory (at least in *ours*) next season, for we basketed roots, while friend pressed a good specimen in the vasculum. This water-course presently joins another which crosses its path, and the two form one, which take their way somehow towards Harbrook Common. At the junction of these brooks there is an extravagant display of vegetable luxuriance. Of course, as the soil here is a fat loam, the pretty peltate-leaved *Hydrocotyle vulgaris* is the prevailing weed. That makes a pretty beginning. Now add to it *Veronica beccubanga,* still in full bloom; *Veronica officinalis,* full of bloom; *Viola palustris,* with leaves as large as crown pieces; *Callitriche verna* and *C. autumnalis* forming emerald green mats, in the swiftest and brightest current of the brawling brook; *Myosotis palustris* in plenty on the margins, hiding the mud with myriads of seedling plants, and *Juncus uliginosus* in a viviparous form, and looking at first sight exactly like *Spergula nodosa,* to which it has no more real resemblance than to a grape-vine or banana.

The united watercourses would serve to indicate the way to Harbrook Common if needful. But no direction is needed, for there it rises bluff before you, a flatter cone than that we traversed on the heath, and much more common-like, with great tufts of furze looking very black upon the tawny groundwork of sand and gravel. For the first time in all our journey we caught sight of a man, who presently disappears over the summit of the cone, and is afterwards seen by us in the character of a furze-cutter. We soon gain the summit and sit down on real grass turf amidst huge knolls of furze, *Ulex Europæus,* and discuss the sandwiches and ale which Mrs. Brown Bear has so liberally and carefully provided us with. After such a tramp what a flavour there is in round of beef, even bread is a delicacy; and if a man cannot then thank God for making everything beautiful in its season he must be "fit for stratagems and spoils," and properly a companion for the bats and owls. At Harbrook Common you are at one of the meeting points of civilization and savagery. To the east, the birthplace of refinement, are half a dozen farms; to the west the pine woods continue, and in that direction we hurry away. Once more we traverse ground covered with lichens and calluna, but there is no dodder, and true ericas are scarce. Geologists may study the substratum, for there are some consi-

derable excavations whence sand has been dug for the gardens of Claremont. We push on through another incipient pine wood, which must have been long undisturbed, for in the cart ruts there are seedling trees now measuring six feet high, and some of them are full of cones, and have borne fruit for more than four years. It is perhaps five and twenty years at least since those cart ruts were formed, and during the intervening period no wheels have disturbed the silence there. Our way leads us through a region covered with pines of large growth. All around is one uniform spongy carpet of pine strewings, save where it is variegated with clumps of Boletus and other fungi, which are here not plentiful, but choice. Here we meet two young men who are employed in the gardens at Claremont, and they guide us to the "Black Ponds," which we had determined to see, even if we should have to sleep on the heather. After traversing a vast breadth of monotonous wood we saw at last the gleaming of water in the distance, and in due time parted from our guides, and sat down beside a lake of some five and twenty acres in extent, the first of a series, called the "Black Ponds." Most appropriately are these lakes named, and this, the first of three, is perhaps the blackest of all. The water is clear as crystal, and the chief source of supply to Claremont. Yet the lake has the appearance of a vast sheet of burnished steel, on which every shadow falls in jet black outlines, recalling the scene in that poem of Moore's which commences—

> "By that lake whose gloomy shore,
> Skylark never warbles o'er."

Is it the peaty character of the soil or the dense umbrage of tall pines by which the lake is enclosed, that gives it this peculiar character? Perhaps the two causes combined are sufficient, and the result is peculiarly interesting. We deposited our baggage beside a small building where a horse is occasionally employed to work a pump, which forces the water of the lake through pipes of some miles in length to Claremont, and then made the circuit of its shores. What a place for botanists! Here are lilies, sedges, rushes, potamogetons, alismas, hydrocotyle, aquatic ranunculuses; and the walk that encompasses the lake takes the visitor amongst magnificent specimens of Scotch fir, silver birch, the alder, holly, and willow; and among the hollies is a noble specimen, which admirably illustrates that poem of Southey's, on the accuracy of which there has been considerable debate, for it produces lobed and spiny leaves below, and smooth entire leaves above, and in some places both kinds of leaves are to be found on the same branch. Many of the aquatic gatherings here were of kinds met with before, but our eyes were soon arrested by large

sheets of a Lysimachia-looking plant which fills several of the great bays and inlets. We unanimously pronounced it to be *L. nummularia.* The patches were smothered with minute yellow dots, which looked like the remains of blossoms of that species. But when we got specimens we found them covered with terminal spikes of unexpanded flowers, which on dissection proved by the united stamens and one-celled berry a relationship to Androsæmum, and we soon determined the plant to be *Hypericum elodes,* which Smith describes as never opening its flowers except during sunshine. But the fungi abounding everywhere on the shores of this lake were the most distinctive and glorious features of the scene. To enumerate them would be no small task. We named a considerable number, basketed more than we could hope to carry, and saw myriads that were beyond our knowledge. Dozens of species that we brought home fell to pieces, and became offensive before we could find time to examine them with a view to determine the species. Of those recognized, in addition to species already enumerated, we saw examples of *Agaricus rubescens, A. excelsus, A. clypeolarius* in lovely rose and rufous tints, *A. granulosa* more than usual mealy in appearance, *A. equestris,* this also occurs in a hollow near where there has been a great fire in the wood, on the way from Harbrook to the engine house; *A. terreus;* the elegant violet coloured *A. nudus* growing very large and the pileus dividing vertically, as if cut with a knife from the circumference to the centre; *A. imbricatus, A. fusipes, A. laccatus* in several shades, from cœrulean blue to grey and dusty brown; *A. leoninus,* remarkably handsome, the pileus a brilliant orange red and large; *A. fascicularis,* a very toadstool-looking species, with rufous cap and slender stem; the ill-looking *Coprinus atramentarius,* and the curious *Paxillus involutus,* with depressed pileus of a dull brown colour. We looked for *Agaricus longicaulis,* but without success. Of *Boletus* and *Bovista* the specimens were extravagantly abundant, and on the shore, nearly opposite the engine house, in front of the clump of holly, there was a group of *Boletus purpureus,* sixteen in number, the smallest measuring five inches across, the largest seven inches and a half. This group was the grandest sight we had seen in the whole of the journey. If the reader knows the species he will feel a quickening of the pulse with sympathy for me, and will not be surprised to learn that I was in such ecstacies that friend thought he would have to hold me down, for I literally danced with delight. Can you imagine that scene? The broad, black, still lake, looking blacker and stiller because of the delicate rustling of the tall clumps of reed and sedge—the grim and solemn pines as rigid as if cast in bronze, for there

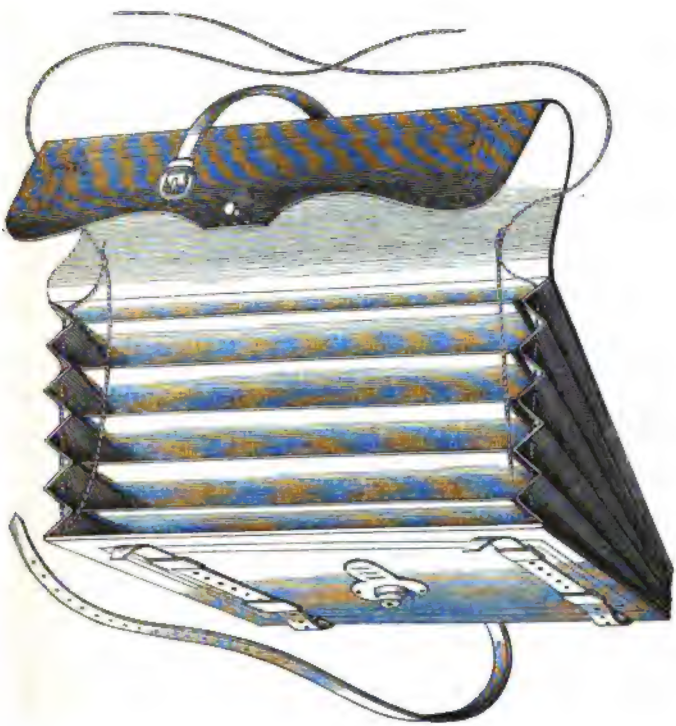
was not a breeze moving among their cloudy tops—the oppressive silence, for no bird whistled, no rabbit rustled, no beetle hummed. There was not one bright flower anywhere visible, and from out of the darkness of the shadows and the deep hues of holly and pine, these sixteen great disks of dazzling vermillion shot forth with the brightness and distinctness of the red lights seen at the head of an advancing railway train emerging from a tunnel at midnight. What huge things they were, with stout stems dotted with purplish red, with a network of greenish-orange pores beneath, that under a lens had the appearance of honeycomb, and their grand caps showing such a blaze of red, deepening here to purple, and there lighting up with a stain of orange, the most magnificent display of colour, I verily believe, it has ever been my lot to behold. Shall I say that mosses and lichens abound here? Of that the botanical reader may be quite sure, and as the season for collecting such things is near at hand, muscologists who read this work are by this hint forewarned and forearmed. I believe it will be found that the route taken in this journey presents as great a variety of mosses and lichens as any similar extent of land within at least a hundred miles of London.

Our tour may be said to have ended at the Black Ponds. We retraced our steps to Harbrook, then crossed over the hill, and made our way towards a white farm-house, which may be seen from the highest point of the common. Beside that farm-house stand two ancient elms, respecting which I have not been able to obtain any particulars worth publishing. The largest of the two is a mere shell; the bark alone remains, but it carries a fine head of recent growth, the original head having long since disappeared. When in its full glory it must have covered a sufficient space of ground for a military camp, as may be judged by these measurements:—At one foot from the ground its circumference is forty-four feet eight inches; at four feet from the ground thirty-one feet four inches. We did not measure it at the ground line, but it cannot be less than seventy feet there. The companion is the handsomest tree of the two, but is considerably smaller. Our way lies now along a hedgerow to the south-east corner of the common, where it is intersected by Copsam Lane. Under this hedgerow there is a grand display of British ferns, among them red-stemmed and red-leaved varieties of *Lastrea filix mas,* and plenty of lady-ferns. This Copsam Lane brings us to another part of Oakshott Heath, and by continuing the road we soon arrive at the school-house where we turned off to the left at starting, in order to reach the heath by that route.

It was a long and pleasant task to turn out all the specimens

beside a bright fire at the "Brown Bear." The papers were all dried, the vasculum stood open before the fire till all was done, and then the whole were packed again for transit home, and when taken out two days afterwards, they were all found to be in the best possible condition. The fungi were packed in moss in baskets, and with them the various tufts of roots reserved for cultivation.

My botanical peregrinations have this season been rendered



VASCULUM FOR PLANTS.

more enjoyable through the adoption of a new species of vasculum. It is a sort of expanding portfolio, containing five leaves of cardboard, bound at the edges with leather. The outer case is of stout board covered with Russia leather, with a flexible leather flap to close the front with lock and key. At the back there are straps and buckles to contract or expand as needful. At starting I fill the case with white blotting-paper, several thicknesses between the cards, and as soon as a speci-

men is chosen it is laid between the blotting, and being fresh requires no laying out. Generally, the specimens when taken out are already nearly dried and well pressed, and only need a shift to fresh paper, and a few days' further pressure, to render them fit for mounting. For convenience of carriage a strap is passed round the case, and by this means it can be slung over the shoulder, or be carried in the fashion of a wallet. When closed the case measures seventeen inches by eleven inches, and when opened to its full extent it has a capacity of nine inches; when closed and empty it is exactly one inch thick. To make this description more intelligible, a diagram is subjoined.

A NEW TABLE-STAND FOR ASTRONOMICAL TELESCOPES.

BY THE REV. E. L. BERTHON, M.A.,

Vicar of Romsey, Hants.

THE want of a cheap and effective stand is much felt by the daily increasing numbers of amateur astronomers, and since the diminution in the prices of achromatic object-lenses has induced many to increase the size of their instruments, the following description of a stand recently invented and constructed will probably be well received.

The contrivance now made public is applicable for telescopes of any size up to eight feet or more, and possesses the advantages of great steadiness and ease in working, combined with lightness and considerable portability. It may be used on any very steady table, but a thick slab of very smooth *slate*, well supported on stone or brickwork, or if in a garden on three stumps of trees arranged in a rustic manner, is by far the best. These slabs are now very cheap, and are not injured by the weather.

The construction of the stand is simple and inexpensive, and secures great accuracy in operation without any particular nicety of workmanship. Its leading feature is that the tube, instead of resting on one joint, or *point d'appui*, has two distinct bearings. In fact it has two pairs of *trunnions*, one of which rests on the top of the main support, the other on the upper ends of two stiff rods, which are moved by a long screw, and perform the part of both steadying rods and elevators.

The tube is divided by the trunnions into three equal

parts, and simply reposes in its bearings without any stiff joints.

The following is a description of the accompanying perspective view.

Fig. 1 represents the new stand, with a 48-inch telescope

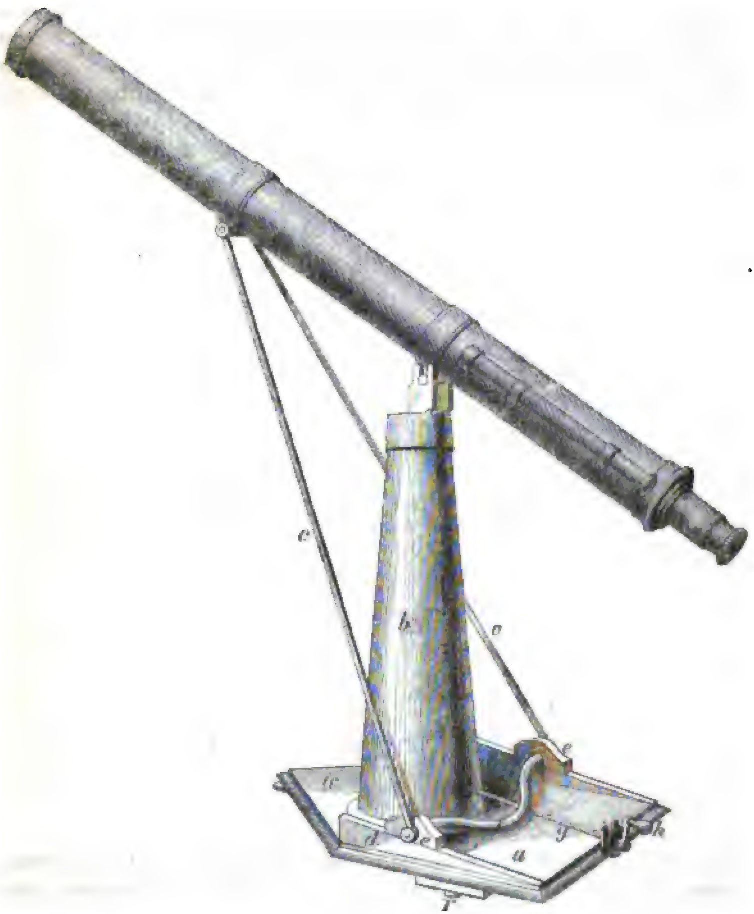


FIG. 1.

attached, and supposed to be placed on a slab of slate, say 3 feet long by 2 wide. *a a,* is a board of well seasoned mahogany, polished, 20 inches by 14. *b b,* a cone of galvanized iron, about 22 inches high, well secured to the board; fixed to the top of this cone are open bearings, to receive the after

trunnions of the tube. *c c*, a pair of steadying—or rather elevating-rods, half an inch thick, having eyes at their ends; those at the upper ends receive the foremost trunnions. *d d*, two inclined planes of mahogany secured to the board, rising 1½ inch, and about 10 inches long; along the tops of these are rounded ridges of brass, accurately straight and smooth, to act as guides. *e e*, two little travellers of box-wood, grooved beneath to slide along the guides. *ff*, a bent rod of ⅝ brass (hollow for lightness), which passes through and fits tight in the travellers, connecting them together; its extremities project

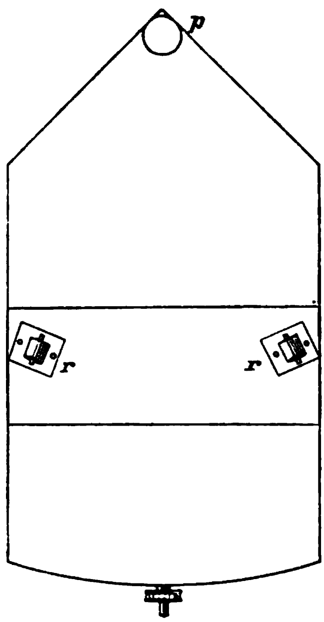


FIG. 2.

like the axle-arms of a carriage, and on them work the lower eyes of the elevating rods. *g g*, a screw 10 inches long (about 20 turns to the inch). It passes through the bent rod *f f*, working in a nut attached to its middle. *h*, a milled head on the screw, and a little winch or handle, which can be removed at pleasure. The screw turns in a bearing fixed to the stand at *h*.

This completes the mechanism for altitude. That for azimuth is very simple, and consists merely of two little well-turned rollers or wheels, *r r*, fixed to the stand beneath, and

so arranged that their axes radiate from the point p as a centre (see Fig. 2). At this point is a flat knob of brass or wood, about which the stand revolves. It may be put on any part of the table or slate slab, the weight being quite enough to keep it steady.

The mode of using this stand is as follows:—

The little winch handle being applied to the screw the tube is rapidly raised or lowered till the altitude of the star is attained, when it may be removed, and the finger and thumb applied to the milled head. Supposing the star to have been found, a gentle pressure towards the left, at the same time gently turning the screw up or down, will keep it in the centre of the field; and this is accomplished without fatigue or inconvenience, as the hand or hands rest on the slab.

This stand is found so steady in practice that the whole weight of the head, reposing on the eyepiece by resting the brow against a little pad, produces no motion or vibration. It has been suggested that some means should be employed to accelerate the motion when a great change of altitude is required. This might be accomplished, but the inventor ventures to think that as a telescope of the above dimensions can be raised from the horizontal plane to an altitude of 65° in one minute, it is rapid enough for most purposes. The inclined planes might have a greater gradient, if a still greater degree of elevation were required.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY CHARLES CHAMBERS AND G. M. WHIPPLE.

1882. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Temperature of Air. Maximum, read at 0 A.M. on the following day.	Minimum, read at 0 A.M.	Daily Range.	At 9.30 A.M., 3 P.M., and 9 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.
	inches.	°	°		inch.	°	°	°		
July 1	30·231	63·1	49·1	·62	·362	70·6	43·2	27·4	7, 2, 2	S by W, S, S by E.
„ 2	29·965	60·2	51·8	·75	·397	69·3	54·5	14·8	8, 7, 9	SW by W, SW by W, SW.
„ 3	30·169	61·9	48·6	·64	·356	69·5	52·5	17·0	3, 9, 4	NW, NW by W, W by N.
„ 4	30·112	61·1	49·1	·67	·362	70·6	50·5	20·1	2, 7, 7	ENE, NW by W, NNE.
„ 5	...	...	...	...	...	72·8	54·1	18·7	...	... ...
„ 6	30·215	66·7	51·6	·61	·394	75·1	53·5	21·6	3, 0, 0	SE by E, SE, SE.
„ 7	30·021	68·6	56·4	·66	·464	76·1	54·4	21·7	1, 2, 5	SW by W, SW, SW by W.
„ 8	30·173	62·2	54·1	·76	·42[illegible]	70·5	52·0	18·5	4, 9, 10	W, NW, WNW.
„ 9	30·205	66·5	51·8	·61	·397	75·2	53·0	22·2	0, 4, 4	NW, ENE, ENE.
„ 10	30·325	69·7	47·7	·45	·345	77·7	50·8	16·9	0, 0, 0	NNE, NE by N, NE by N.
„ 11	30·339	67·5	51·5	·59	·383	76·1	51·9	24·2	10, 10, 8	NE by N, E by S, ESE.
„ 12	...	...	...	...	...	77·8	52·2	25·6	...	... ...
„ 13	30·423	61·3	50·0	·68	·373	68·7	58·9	9·8	10, 8, 10	NNE, NE, NE.
„ 14	30·329	67·7	54·3	·64	·432	77·9	46·3	31·6	10, 10, 10	—, —, WSW.
„ 15	30·152	70·4	53·2	·56	·416	80·5	49·5	31·0	5, 7, 10	W, —, N.
„ 16	30·160	57·0	44·0	·64	·304	...	54·6	...	10, 10, 6	NE by E, NE, NE.
„ 17	29·946	61·0	44·3	·57	·307	70·0	44·0	26·0	10, 5, 5	SW, SW by W, W by N.
„ 18	29·789	54·5	38·1	·57	·247	62·9	45·0	17·9	10, 5, 3	NW by W, W by N, NNW.
„ 19	...	...	...	...	...	67·6	39·5	28·1	...	... ...
„ 20	29·756	57·6	41·8	·58	·281	64·8	48·5	16·3	4, 9, 10	NW, —, —.
„ 21	29·724	55·4	55·3	·98	·447	62·9	45·3	17·6	10, 10, 10	S by E, SSE, SSE.
„ 22	29·559	57·1	50·7	·81	·382	66·7	56·6	10·1	10, 10, 10	S by W, W by S, W by N.
„ 23	29·861	58·5	45·5	·64	·320	66·7	48·4	18·3	6, 8, 7	W by N, WSW, W by S.
„ 24	30·085	57·6	42·1	·59	·284	65·6	43·4	22·2	6, 10, 10	WSW, SW, W by N.
„ 25	29·924	57·1	51·8	·84	·397	64·6	50·4	14·2	10, 10, 10	W, W by S, NW by N.
„ 26	...	...	...	...	...	67·5	46·6	20·9	...	... ...
„ 27	30·185	64·2	52·1	·67	·401	72·3	46·0	26·3	6, 6, 7	—, SW by W, S by W.
„ 28	30·021	66·3	50·9	·60	·385	75·4	45·6	29.8	4, 6, 7	W, —, S by E.
„ 29	29·991	65·7	50·8	·61	·384	75·1	50·2	24·9	3, 3, 6	NNW, W by S, NW by N.
„ 30	30·186	60·3	42·3	·54	·286	69·4	52·6	16·8	1, 6, 4	NE, N, NE by N.
„ 31	30·243	58·3	42·9	·59	·292	68·2	46·0	22·2	7, 4, 2	ENE, E by S, E by S.
Monthly Means.	30·077	62·1	48·9	·65	·364	...	...	21·1	...	...

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—JULY 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12																																
A.M. 1	1	8	8	5	5	13	5	5	5	1	1	1	7	1	3	12	3	4	3	4	3	15	4	4	6	5	0	0	3	10	5	4·8
2	1	7	4	3	4	12	7	6	2	0	1	1	7	1	3	12	1	3	2	4	2	12	3	4	5	5	1	1	2	9	3	4·1
3	1	6	6	2	5	12	5	4	3	1	0	0	8	2	3	10	1	6	3	2	4	13	2	3	8	6	1	1	2	7	2	4·2
4	0	6	5	2	5	12	7	5	2	1	1	0	7	1	4	7	1	8	3	2	2	12	4	5	8	5	1	1	1	9	5	4·3
5	1	9	7	1	3	6	6	5	2	1	0	0	8	3	4	9	1	9	3	2	3	17	3	3	10	6	1	1	2	6	5	4·4
6	1	16	7	4	5	10	4	6	2	1	1	1	10	3	4	10	2	8	3	3	1	11	6	5	8	6	2	1	3	9	5	5·1
7	1	15	7	9	8	10	6	7	5	4	2	0	12	3	5	14	3	12	2	3	4	11	6	5	8	9	3	0	3	12	5	6·3
8	4	14	10	8	5	11	10	7	8	8	2	2	16	2	4	16	7	13	2	3	2	17	7	7	13	11	3	3	2	10	9	7·6
9	12	22	11	9	3	12	8	9	8	11	4	2	15	3	4	11	16	14	4	6	2	17	9	9	14	13	2	2	5	8	12	8·9
10	14	24	11	7	5	13	10	9	10	10	5	3	14	2	5	15	15	14	5	5	4	21	12	10	16	12	2	4	6	10	12	9·8
11	15	24	10	9	5	14	10	10	10	10	9	5	15	2	6	15	15	16	10	6	5	18	12	11	16	10	2	3	7	10	15	10·5
12	16	28	8	7	5	14	11	7	10	11	8	8	13	5	8	15	15	15	8	4	7	15	14	13	13	10	3	3	7	10	15	10·5
P.M. 1	15	26	6	5	3	16	11	9	10	14	6	10	12	2	7	17	12	12	12	4	6	22	10	11	9	8	4	5	8	10	17	10·3
2	15	26	7	4	6	19	12	7	9	11	9	9	10	4	4	13	10	11	12	4	7	21	14	11	6	9	3	5	9	8	18	10·1
3	17	26	7	4	5	17	10	9	7	11	8	8	10	4	6	10	13	10	13	4	8	19	13	13	10	6	4	6	8	9	18	10·1
4	16	22	5	5	5	10	13	7	8	13	10	9	11	5	8	7	12	16	12	4	9	20	14	10	7	7	4	4	7	9	17	9·9
5	15	22	8	4	7	19	14	7	12	11	8	9	12	4	6	9	13	15	13	2	9	17	13	10	9	5	3	5	10	14	20	10·5
6	13	18	7	4	9	13	10	5	9	11	6	8	11	5	4	9	9	12	12	3	10	18	12	7	5	6	12	2	13	9	17	9·3
7	9	15	5	6	7	16	8	4	11	10	6	8	11	3	2	9	6	10	9	1	10	19	8	5	3	4	10	6	7	11	17	8·3
8	6	12	4	6	8	15	12	1	8	10	6	6	9	1	1	11	7	8	8	3	17	15	7	6	2	2	10	5	5	8	14	7·5
9	8	8	1	5	24	18	8	2	5	7	4	5	6	1	3	5	7	1	10	4	14	8	5	8	8	3	4	5	2	9	15	6·9
10	7	11	3	6	15	15	9	1	2	5	1	6	2	6	7	5	7	4	12	4	19	4	5	7	3	1	1	3	10	5	17	6·5
11	7	9	5	6	14	16	9	3	2	3	2	2	2	3	8	3	4	4	9	5	13	5	5	9	4	1	1	5	12	4	16	6·2
12	5	7	5	5	12	5	6	4	1	2	1	7	1	2	8	1	4	2	4	3	17	7	4	8	6	0	1	5	10	4	9	5·0
Total Daily Movement.	200	381	157	126	173	318	211	139	151	167	101	110	229	68	117	245	184	227	174	85	178	354	192	184	197	150	78	76	144	210	288	7·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Aug. 1	30·059	62·4	47·0	·59	·337	71·8	49·9	21·9	3, 5, 10	E by N, E by N, E.	·000
„ 2	...	...	...	...	...	76·9	55·0	21·9	...	... ...	·000
„ 3	29·997	65·3	55·3	·72	·447	72·4	55·4	17·0	9, 9, 9	SW by S, SSW, SW.	·000
„ 4	29·875	62·9	56·8	·82	·470	71·7	53·7	18·0	8, 8, 9	SW by S, SSW, SW.	·007
„ 5	29·865	62·1	49·9	·67	·372	71·4	55·6	15·8	10, 10, 8	W, W by S, W.	·157
„ 6	29·917	61·4	52·0	·73	·400	68·9	57·9	11·0	10, 9, 10	SW, SW, WSW.	·137
„ 7	30·047	68·6	61·6	·80	·551	75·7	61·1	14·6	10, 9, 7	SW, SW, SW.	·013
„ 8	30·079	68·2	61·2	·80	·544	76·1	62·4	13·7	8, 9, 4	SW by W, SW, SW by W.	·003
„ 9	...	...	...	...	...	80·9	57·4	23·5	...	... ...	·002
„ 10	30·058	67·8	57·5	·71	·481	77·9	59·7	18·2	9, 5, 6	NW, SW by W, WSW.	·000
„ 11	29·993	64·5	49·5	·60	·367	74·3	57·9	16·4	10, 4, 3	W by S, W, W.	·000
„ 12	30·031	62·8	46·7	·58	·333	71·0	50·6	20·4	4, 6, 9	N by E, NW by N, N.	·000
„ 13	29·906	66·0	52·7	·64	·409	75·2	52·4	22·8	9, 8, 10	E by S, ENE, ENE.	·000
„ 14	29·982	63·9	53·2	·70	·416	72·6	56·3	16·3	7, 7, 10	E by N, E by N, E by N.	.000
„ 15	29·802	68·8	56·3	·66	·462	77·5	52·4	25·1	8, 4, 1	SW by W, S by W, SW by S.	·000
„ 16	...	...	...	...	...	74·7	58·5	16·2	...	... ...	·017
„ 17	29·694	57·9	47·8	·71	·346	68·9	55·1	13·8	5, 7, 10	W by S, WSW, WSW.	·000
„ 18	29·819	55·0	46·2	·74	·328	62·8	48·5	14·3	9, 10, 9	WSW, W, W by N.	·061
„ 19	29·797	53·0	53·5	1·00	·420	62·6	51·8	10·8	10, 10, 7	SSW, SW, W by S.	·080
„ 20	29·994	54·2	42·5	·67	·288	60·8	50·6	10·2	8, 10, 7	NW by W, NNW, WNW.	·137
„ 21	30·130	57·4	43·9	·63	·303	64·0	45·0	9·1	8, 10, 10	N by W, NW by W, NW by W.	·003
„ 22	30·046	59·1	52·4	·80	·405	68·4	51·9	16·5	10, 10, 10	W, —, WSW.	·007
„ 23	...	...	...	...	...	71·8	55·7	16·1	...	... ...	·028
„ 24	29·852	61·6	48·0	·63	·349	68·1	58·0	10·1	8, 9, 1	WSW, SW, S by W.	·000
„ 25	29·551	57·8	50·9	·79	·385	69·0	50·3	18·7	6, 9, 8	S by E, SW by S, SSE.	·010
„ 26	29·467	54·4	53·1	·96	·415	63·0	50·4	12·6	10, 10, 10	SW by S, SSE, ENE.	·426
„ 27	29·408	59·7	53·8	·82	·425	67·5	55·2	12·3	9, 10, 10	S by E, S by E, S.	·525
„ 28	29·639	61·6	52·4	·73	·405	71·9	49·5	22·4	7, 6, 6	S, S by W, S by W.	·022
„ 29	29·753	58·6	51·9	·80	·398	67·8	52·5	15·3	6, 8, 6	SW by S, W by N, NW by W.	.107
„ 30	...	...	...	...	...	68·9	49·4	19·5	...	... ...	·013
„ 31	29·810	56·5	51·2	·83	·389	64·6	55·6	9·0	10, 9, 10	S by E, W, WNW.	...
Monthly Means.	29·868	61·2	51·8	·74	·402	...	...	16·2	...	... ...	1·755

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—AUGUST 1863.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
	Hour. 12																																
A. M.	1	9		2	7	6	11	16	11	8	6	9	6	5	10	3	12	11	8	8		6	2	5	12	3	11	11	1	3	1		7·3
	2	8	385	4	7	5	11	12	14	8	6	12	5	7	9	3	11	10	7	8	219	6	2	5	12	5	12	6	6	3	3		7·4
	3	10		5	4	4	12	14	11	8	6	11	6	8	10	3	9	8	8	6		4	3	5	15	5	13	3	5	5	2		7·3
	4	9		5	6	5	11	10	11	9	8	8	3	8	10	5	6	8	8	7		3	2	4	13	8	13	6	2	4	2	327	6·8
	5	7		4	12	4	14	15	10	7	9	10	3	5	11	5	11	10	7	6		3	4	9	13	5	9	10	2	5	2		7·6
	6	8		4	11	4	16	15	12	8	8	11	3	5	14	3	11	8	6	8		3	3	8	10	4	8	9	2	8	2		7·6
	7	14		9	11	4	18	13	12	8	10	12	5	5	20	9	14	12	5	10		6	4	8	14	5	9	13	3	10	3		9·5
	8	14		14	21	5	19	14	15	9	10	13	5	10	25	13	19	8	10	10		5	6	11	15	10	9	15	5	10	4		11·6
	9	13		14	22	3	19	13	18	11	9	12	6	9	29	19	20	12	14	8		8	7	8	11	17	8	15	9	14	7		12·7
	10	13		17	23	4	20	15	15	12	9	15	8	9	25	21	17	13	15	11		7	6	15	14	12	7	28	13	17	8		13·7
	11		8	15	23	4	18	14	19	11	7	14	8	9	27	26	17	14	15	10	17	7	6	20	14	17	10	21	12	16		34	14·9
	12		10	20	22	5	21	13	17	10	10	14	6	10	24	22	21	19	15	8	17	9	6	23	13	26	12	26	10	17		28	15·7
P. M.	1		8	25	25	8	23	14	19	8	11	11	7	12	23	28	25	20	15	9	16	8	6	20	14	25	14		18	18		24	16·0
	2		14	21	25	10	20	16	17	9	14	10	7	13	21	26	24	17	16	15	21	8	3	22	15	23	12		10	16		26	16·1
	3		14	19	20	10	18	17	19	8	14	10	4	11	24	29	26	21	14	9	16	11	3	22	16	27	11	115	13	13		15	15·5
	4		14	15	21	9	20	20	19	11	16	10	5	15	21	27	23	14	15	9	15	8	4	24	17	28	11		14	10		10	15·2
	5		17	18	10	14	15	15	16	13	15	9	6	20	18	24	25	11	16		17	8	7	24	17	8	9		13	10		11	14·3
	6		15	19	12	12	15	18	17	11	14	9	5	20	18	26	23	10	16		13	6	9	18	19	10	10	12	7	5		9	13·3
	7		14	17	16	11	20	16	14	12	14	5	6	21	13	23	22	7	14		10	9	4	19	17	10	20	13	4	5		11	13·1
	8		6	12	17	14	15	14	13	7	10	6	13	20	6	12	16	7	10		6	2	5	15	13	6	12	10	1	1		14	10·1
	9		9	8	5	10	15	13	8	8	8	5	13	14	2	13	13	8	10		8	4	6	11	10	14	11	4	0	2		9	8·6
	10		6	11	5	10	15	10	8	8	6	7	13	13	4	11	11	7	10		8	2	5	12	9	9	9	7	1	5		9	8·2
	11		5	9	4	14	15	15	9	6	9	6	12	14	3	9	10	8	9		8	3	6	13	6	12	16	8	9	5		7	8·9
	12		4	7	5	11	18	13	8	3	7	6	9	9	3	7	10	7	8		6	2	5	13	5	9	12	5	5	3		8	7·4
Total Daily Movement.		634		294	334	186	399	340	332	213	236	285	164	272	370	367	396	270	271	539		138	114	334	314	293	268	332	160	205	576		11·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A. M., 2 P. M., and 5 P. M. respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Sept. 1	30·045	55·5	43·2	·66	·295	63·1	44·0	19·1	6, 4, 4	WNW, SW, W by N.	·063
„ 2	29·792	53·3	52·1	·96	·401	63·6	52·4	11·2	10, 10, 10	S by W, SW by S, S by W.	·012
„ 3	29·748	57·9	51·5	·80	·393	66·1	54·2	11·9	8, 8, 9	S, S by W, SW.	·196
„ 4	29·856	57·5	49·0	·75	·361	63·9	50·3	13·6	7, 9, 6	WSW, S by E, SW by S.	·326
„ 5	29·709	54·7	52·1	·92	·401	61·8	46·1	15·7	10, 10, 10	WSW, S by W, SW.	·062
„ 6	...	...	...	...	...	62·4	47·1	15·3	...	... ...	·280
„ 7	29·698	56·7	41·7	·60	·280	62·7	51·9	10·8	3, 4, 7	SW by W, W by S, WSW.	·360
„ 8	29·959	54·1	47·9	·81	·347	60·7	46·6	14·1	5, 10, 10	WSW, SSW, SW.	·003
„ 9	29·747	55·8	53·0	·91	·413	62·9	51·0	11·9	9, 9, 9	S, —, N by E.	·072
„ 10	29·941	49·8	42·9	·79	·292	60·2	48·5	11·7	0, 10, 7	NW by W, N, W.	·304
„ 11	30·198	53·2	41·6	·67	·279	60·0	43·5	16·5	4, 6, 2	NW, W by N, NW by W.	·000
„ 12	30·216	54·7	44·7	·71	·311	61·1	43·9	17·2	3, 9, 10	SW, SW, SW.	·000
„ 13	...	...	...	...	...	64·1	49·0	15·1	...	... ...	·000
„ 14	30·331	52·4	45·8	·80	·323	59·3	43·8	15·5	10, 10, 10	W by S, W by N, NW by W.	·000
„ 15	30·136	52·1	44·9	·78	·313	58·5	51·5	7·0	10, 10, 10	W, WSW, SW by W.	·000
„ 16	30·041	53·9	41·9	·66	·282	60·1	51·5	8·6	4, 7, 8	W, W, W by N.	·000
„ 17	30·106	55·5	45·1	·70	·315	62·5	42·8	19·7	7, 4, 1	W, WSW, WSW.	·000
„ 18	30·068	56·9	47·6	·73	·344	63·7	47·0	16·7	10, 4, 0	SW, SW by S, SW.	·000
„ 19	29·737	57·8	53·4	·86	·419	68·3	49·0	19·3	3, 9, 10	SW, SW, SW.	·000
„ 20	...	...	...	...	...	58·2	50·1	8·1	...	... ...	·597
„ 21	29·117	49·5	41·3	·75	·276	57·6	...	...	8, 9, 4	WSW, W, WNW.	·010
„ 22	28·930	49·9	40·8	·73	·272	57·7	45·9	11·8	10, 6, 7	WSW, WSW, SW by W.	·008
„ 23	29·148	49·5	42·1	·77	·284	58·1	41·2	16·9	4, 7, 6	WSW, SW, SW.	·005
„ 24	29·388	47·3	44·9	·92	·313	56·5	38·0	18·5	10, 8, 9	S, S by W, S.	·059
„ 25	29·722	52·8	44·4	·75	·308	60·2	41·1	19·1	2, 5, 3	SW, SW, SW.	·178
„ 26	30·074	49·4	43·0	·80	·293	57·8	35·3	22·5	8, 7, 7	W, W by S, W.	·009
„ 27	...	...	...	...	...	57·9	36·5	21·4	...	... ...	·014
„ 28	29·834	49·4	40·5	·74	·269	56·7	37·3	19·4	10, 4, 1	W by S, W by S, W by S.	·204
„ 29	30·011	50·4	41·3	·73	·276	58·1	36·0	22·1	2, 4, 3	SW, SW by S, SW.	·056
„ 30	29·728	52·4	47·0	·83	·337	60·8	30·1	30·7	9, 10, 10	NE, SSE, ESE.	·000
Monthly Means.	29·818	53·2	45·5	·77	·323	...	...	15·9	...	... ...	2·818

*To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPTEMBER 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. 12																															
A. M. 1	7	9	10	3	5	10	23	11	6	9	5	3	6	4	4	8	6	3	1	14	11	13	7	3	6	4	5	19	3	1	7·3
2	5	12	12	4	5	10	27	7	5	7	4	4	7	4	3	8	5	5	1	12	11	13	6	1	7	2	5	18	4	1	7·2
3	5	11	10	3	5	11	26	6	6	7	4	5	6	3	4	6	3	6	4	12	12	12	7	2	6	4	5	19	3	1	7·1
4	5	11	8	3	4	11	24	8	5	6	3	4	4	4	5	6	5	3	3	12	9	13	8	2	2	4	2	20	5	1	6·7
5	4	10	6	5	4	10	22	7	6	7	7	4	6	4	5	5	3	4	6	11	10	13	9	3	4	2	4	18	4	2	6·8
6	5	10	5	4	6	9	18	9	4	8	2	6	6	4	5	7	5	7	5	13	9	10	8	1	3	2	4	22	1	2	6·7
7	4	10	10	3	7	11	13	8	5	4	3	3	6	5	6	8	5	5	3	13	9	11	9	5	4	2	5	25	2	1	6·8
8	7	14	16	5	12	18	17	10	7	8	5	6	7	3	8	7	7	7	2	13	12	11	12	9	4	4	12	24	2	3	8·9
9	10	14	15	9	13	17	20	13	9	10	10	6	11	6	8	10	8	7	5	11	14	12	14	9	6	5	16	24	5	2	10·6
10	10	15	17	14	17	17	20	13	10	14	12	10	14	6	12	13	8	11	10	8	15	12	18	10	12	6	20	13	9	2	12·3
11	12	17	17	13	17	17	24	16	5	14	11	13	11	5	13	13	11	11	22	13	14	13	16	12	13	10	16	10	13	6	13·3
12	12	15	18	10	20	17	23	15	5	11	10	13	13	6	13	14	12	11	24	10	14	14	14	10	13	12	19	11	15	10	13·5
P. M. 1	13	22	16	16	21	16	23	16	7	13	9	12	13	8	11	13	12	7	27	14	16	18	14	9	15	12	22	16	11	13	14·5
2	12	19	16	19	15	18	21	18	5	15	10	12	11	8	13	11	12	6	26	16	18	14	11	8	11	11	24	18	11	10	14·0
3	13	19	15	18	15	15	23	17	3	11	6	11	13	7	13	12	10	4	23	17	14	15	16	8	13	12	24	17	9	12	13·5
4	11	21	18	16	19	15	22	15	2	9	6	9	11	7	13	11	11	8	24	19	11	17	9	12	10	9	22	17	9	11	13·1
5	9	16	9	19	19	15	18	17	5	6	5	7	10	5	10	7	10	8	28	15	11	11	9	9	8	7	22	13	9	13	11·7
6	5	15	7	13	17	14	19	16	2	5	4	7	9	6	9	7	8	6	29	11	9	11	7	10	6	3	23	7	8	16	10·3
7	8	13	6	11	13	13	16	14	1	5	3	4	8	3	8	6	6	4	28	9	11	15	6	10	4	2	20	8	6	16	9·2
8	11	13	6	8	16	14	13	15	1	4	4	6	5	4	9	5	6	5	28	10	8	15	7	11	4	3	20	7	3	18	9·3
9	8	9	6	7	15	16	14	13	1	4	4	5	11	4	8	5	6	5	28	9	8	18	5	8	5	3	18	6	2	25	9·0
10	8	9	3	5	9	16	15	12	3	3	5	5	4	3	9	6	3	4	29	9	11	9	6	8	3	3	21	6	1	21	8·1
11	10	9	2	3	11	19	11	11	7	6	5	5	3	3	7	7	4	3	28	11	13	6	5	3	3	4	25	6	0	20	8·3
12	9	6	1	4	11	22	10	10	5	4	4	5	3	4	6	6	4	2	23	11	13	7	8	4	4	3	19	3	1	23	7·7
Total Daily Movement.	203	319	249	215	296	346	462	297	115	190	141	165	198	116	202	201	170	142	407	293	283	298	226	162	166	129	373	347	136	230	9·8

A NEW KIND OF MINIATURE.

A VERY ingenious and beautiful application of optical principles to the mounting of photographic miniatures has been recently made by Mr. Henry Swan, of the "Casket Portrait Company," Charing Cross. The effect of the new process is to exhibit the subject of the portraiture with life-like verisimilitude, and in natural relief. You take up a small case, and look through what appears to be a little window, and there stands or sits before you, in a pleasantly-lighted chamber, a marvellous effigy of a lady or gentleman, as the case may be. The projection of the nose, the moulding of the lips, and all the gradations of contour, are as distinct as if an able sculptor had exercised his skill; but the hair and the flesh are of their proper tint, and the whole thing has a singularly vital and comfortable look. Indeed, were it not for the reduction in size, it would be difficult to avoid the belief that an actual man or woman, in ordinary dress, and with characteristic expression, was presented to your eye. We might, indeed, compare these admirable pictures to accurate reflections of the persons themselves in a diminishing glass, and no one can see them without being struck with their marked superiority over ordinary portraits.

In order to produce these beautiful and unexpected effects, two portraits, taken at a suitable angle, are arranged upon two prisms, placed almost in contact so as to form a quadrangular block. Each prism is ground to an angle of 39° or 40°; one picture is placed at the back of the combination and another at the side of the prism nearest the eye. When we try to look through the combination, the two images are combined in one stereoscopic picture, and the action is thus explained in a paper read by Mr. Swan before the British Association, at their Newcastle meeting, where the portraits were much admired:—"The reason of this curious phenomenon is, that all the rays which fall on one side of a line perpendicular to the surface of the prism next the eye suffer total reflection at the oblique inner surface of that prism, while the rays which fall on the other side are transmitted unaltered through the body of the combination. Thus it is that one of the eyes only perceives the object at the back of the prisms, while to the other the picture at the side is alone visible, that, apparently, being at the back also. It necessarily follows that if the pictures have been taken in accordance with the principles of binocular vision, the resulting image seen in the interior of the crystal will be quite solid, every detail being wrought in perfect relief with the most exquisite delicacy. To the scientific observer it will be evident that, to produce the effect intended, care must be taken not

only that the picture shall not be misplaced, so as to produce the pseudo-scopic effect, but also that the image which suffers reflection shall be reverted, to compensate for the reversion which takes place when reflexion occurs.

In addition to portraits destined for morocco cases, and of ordinary minature sizes, much smaller ones are taken and mounted in exceedingly pretty little caskets of fine gold. These form as elegant little shrines as any lover could wish to receive the effigy of his mistress, and far surpass any other mode yet devised of connecting portraiture with ornamental jewellery. The stereoscopic effect is quite as perfect as in the larger patterns, and the photographs are so judiciously coloured that their fidelity to nature is in nowise impaired.

All the casket portraits are viewed as transparencies, the photographs being printed from ordinary negatives on small mica plates which are affixed to the prisms.

Wehave appended Mr. Swan's *rationale* of his process without comment, andour optical readers can investigate this curious question for themselves. There is not the slightest doubt of the magical relief of the portraits, but we are not quite sure that the effect is entirely dependent upon the causes which Mr. Swan particularises. We recommend all who have an opportunity of going to Charing Cross, to see these portraits for themselves. Few will be contented to leave the studio without making arrangements to possess some specimens of the artist's skill, and all must admit that they have never before seen the stereoscopic principle so beautifully carried out. Mr. Swan's is one of those happy inventions in which art and science join, and his labours will be appreciated to the extent that they are known.

THE EARTHQUAKE OF OCTOBER, 1863.

Although earthquakes in Great Britain are by no means rare occurrences, that which occurred on the 6th of October was remarkable for an amount of violence seldom experienced in these usually quiet isles, and those who did not themselves feel the late concussion were scarcely less startled by the alarming accounts with which the newspapers were filled on the following day.

Our present purpose is to endeavour to place on record the most important facts that were observed, and to supply a little earthquake philosophy, by the light of which the incidents may appear in a more interesting light. Thanks to telegrams, newspaper correspondents, and the penny post, the materials are not scanty, although few can be affirmed to be exact. In its extent the shaking was reported from a point about twenty miles off Pembroke, in the west, to some place of which the name is not given, on the Yorkshire coast, to the east. If, however, it was really felt at the latter place,* it must have been very feeble, and we are not aware of any authentic record of noticeable disturbance more east than Gad's Hill, near Rochester, where it gave Mr. Charles Dickens the sensation of a great beast uplifting itself under his bed. At Ashford, in Kent, we are assured it was not felt, and thus its eastern range was probably very small.

In the absence of accurate standards of measurement, we are driven to secondary evidence in our attempt to say where the greatest violence was exerted; but no place appears to have been more strongly affected than Hereford and its vicinity, while the concussion may have been equally severe in the Black Country of Staffordshire, and on Sedgely Beacon, N.N.W. of Dudley, in the same county. It was likewise severe at Lyerney, in Gloucestershire, and was called violent at Taunton and Wellington, in Somerset.

The time at which the principal shock was felt can scarcely have been the same in different localities, even making allowance for the probable difference of clocks. Everton, near Liverpool, claims to have felt premonitory rumblings at 11 P.M. of the night of the 5th; Clifford, in Herefordshire, was stated to have been affected at 2·30, and Taunton is stated to have received a violent quaking at 2·40.

Of these early times we may regard that of Everton as doubtful, and that of Clifford, from which we have received more accurate information, as a decided mistake. The latest shock is stated to have been felt at Swansea and Nailsworth, which

* We are informed it was *not* felt at Scarborough.

enjoyed a parting rumble about 4 P.M., after having had their share in the earlier distribution. Sorting out, from the various communications to the daily press, a few of the most important places in the line of attack, we may make two lists, the first comprising those in which the shaking is alleged to have been experienced about 3 A.M. on the morning of the 6th, and the second including others chiefly affected at or near 3·30 A.M. of the same day. The first list, it will be seen, is rich in western names. It is as follows :—

Twenty miles off Pembroke	about	3
Newport, S. Wales, first shock		3·10
Merthyr Tydvil	about	3
Neath	,,	3
Cardiff	,,	3
Upwey, Dorset	,,	3
Gloucester	,,	3
Portsmouth	,,	3
Stone, Staffordshire	,,	3

The half-past three time-list comprises localities far apart—

Axminster	3·30
Barnstaple	3·30
Monmouth	3·30
Beeston Observatory (Notts)	3·30
London	3·30
Dorrington, near Shrewsbury	3·30
Hereford and vicinity	3·23

The force of the earthquake was very trifling compared with the gigantic concussions of which other countries are frequently the seat, and we possess very slender means of measuring its intensity by actual reference to work performed. Mr. E. J. Lowe informs us that many persons in the neighbourhood of Beeston Observatory, near Nottingham, were awoke by the shaking of their beds and windows, and to this general testimony he adds the more precise intelligence that the motion of his earthquake-pendulum was from W.N.W. to E.S.E., and "the displacement of chalk by the thirty-feet rod was half an inch, the index-needle moving the chalk so as to leave an oval or rather lengthened-oval hole." He considers there must have been at least two shocks —one at 2·35 and another at 3·30 A.M. During the latter, "the zero pencils on his atmospheric recorder marked the paper in a remarkable manner."

No large object is reported to have been displaced anywhere; but it is not unlikely that careful inquiries would lead to the discovery of fissures in old and weak buildings or walls; though we should think the concussion could not have had force to damage any that were sound. At Barnstaple, Liverpool, Sedgely, and some other localities, small articles are affirmed

to have been thrown down, and a clock was stopped at the Royal Hotel, Waterloo. The noise from the shaking of doors and furniture caused many persons, in various districts, to fancy that burglars were violently breaking into their premises, and notwithstanding the doubts that certain incredulous persons have thrown upon the statements that alarming sounds were heard, besides the rattling of domestic apparatus, we are satisfied that some at least of these stories are true.

Noises of undoubted loudness often pass by with little notice if attention is otherwise directed. Their effect upon the ear will also depend greatly on the nervous condition of those who hear them. Thus, a few weeks before the earthquake, a loud peal of thunder rolled over London between nine and ten one evening. It caused great alarm to the spectators at one of the theatres, who may have been worked up by a sensation story; and in one house we know it induced the cook to rush into the scullery, expecting to witness a tragic catastrophe amongst her plates and pots, while in an adjacent house the sound was scarcely heeded by any member of the family.

We must, in the face of such facts, which every one's experience can easily multiply, not place too much stress upon negative evidence, and fancy that no noise existed because some persons did not attend to it. Fortunately, we are able to give some reliable information on this point, and shall first cite a very interesting letter with which we have been favoured by the Rev. Henry Cooper Key, whose scientific attainments give great value to his testimony.

Stretton Rectory (Mr. Key's abode) is about three miles west of Hereford, and he tells us that "the impression of all those in this neighbourhood qualified to judge is that the shock was more severe here than elsewhere. The magnitude of the sound is undoubted. My house is a new one, and very strongly built, and I certainly did not confound the noise caused by the shaking of articles in the house with that of the earthquake. I distinctly heard the noise approaching for some seconds, until the house was violently jarred, as if a train had run against it, and then the solemn sound died away in the distance: it was *much deeper* than thunder, and almost my first words were, 'Surely no one could have slept through such a noise as that.' The jar that went through my frame was horrible, and such as I shall never forget. I am so sound a sleeper that mere thunder hardly ever wakes me."

Mr. Key considers the shock was propagated in a straight line nearly N.E. and S.W., but also "diverging in two directions, say from Macclesfield towards Pembroke, and also from Sheffield towards London."

Our valued astronomical contributor, the Rev. T. W. Webb,

who resides at Hardwick Parsonage, about fifteen miles due west of Hereford, did not leave his telescope on the night of the quake until half-past two. He was awakened by "a wonderful clattering of doors and windows," then went to sleep again. Mr. Webb found little certainty in many of the accounts given concerning the direction of the shock, but the balance of evidence was in favour of its arrival from W.S.W. He remarks, "There is the strongest discrepancy between the accounts of people living in almost contiguous houses, partly from temperament, I suppose, and I suspect partly from the diagonal or perpendicular presentation of the walls." This last observation is highly important; and presuming the concussion wave to have travelled in any given line, say, from W.S.W., towards the opposite point of the compass, the effects of the shock upon buildings of somewhat similar height and strength would be found to vary with the direction of their walls.

An intelligent farmer's wife gave Mr. Webb the following interesting particulars:—Her husband, being awake, heard the sound coming, as of thunder, only not quite like thunder, somewhat lighter, then the whole house trembled altogether, then a door between their room and the next was so slammed to and fro, she thought her sick child on the other side was attempting to open it. Her husband went to open it, and found all safe, and then, but not before, came one great push at the bed.

In the neighbourhood of Clay Cross, near Chesterfield, the shock was scarcely noticed, and in a letter from Charles Binns, Esq., of that place, we are informed that although many men were working at night in the pits and about the works, none mentioned any unusual sound or motion. Mr. Binns considers that it did not extend so far north of the Backbone Ridge as Clay Cross and Chesterfield.

Some observers, in what appears to have been the line of principal disturbance, thought the shock came from the eastward, and others from the west, but it is very easy to be mistaken in this matter. Where the local earth-structure presents curved beds of emergent hard rocks lying between bad conducting bodies, such as soft clays or loose sand, the concussion wave would be materially deflected; but, notwithstanding minor peculiarities, the general direction was probably from some point west of south to another point east of north. The *Earthquake Catalogue* of the British Association, published in 1858, states the mean horizontal direction of British earthquakes to be "from south to north, veering more or less to the east or west, but having on the whole a direction passing through the probable focus of the Lisbon earthquakes, and of the Canary Islands." The same work informs us that 234 earthquakes are

recorded as having occurred in the British Isles and Northern Isles, from the 11th century to the 19th, of which 56 took place in winter, 42 in spring, 52 in summer, and 67 in autumn.

Superstition has, in all ages, made use of earthquakes by exaggerating their horror, misstating their character, and ascribing them to causes of an unnatural kind. Science, however, shows that they are phenomena continually occurring: not a day passes in which many do not shake certain portions of the earth, and though we are only beginning to understand the laws that regulate their action, enough has been ascertained to warrant the positive assertion that they are subservient to purposes of order, and, strange as it may seem, belong to the *conservative* forces operating upon our globe.

The question, "What is an earthquake?" will occur to all inquiring minds, and can only be approximately answered. Formerly it was fancied that the earth was a sort of bottle filled with a huge mass of molten matter, in an incandescent state, and then earthquakes and volcanic eruptions were easily accounted for by supposing that the fiery fluid in its expansions burst more or less completely through the crust of our globe. This theory was partly founded upon the hasty induction that because, within small limits, descending into the earth conducted us to a warmer region, it must continue to do so within any limits, and that we should soon come to a zone in which all known substances would be melted with fervent heat; and partly upon an equally unwarrantable corollary from the nebular hypothesis. According to this supposition, all the globes that people space were once *gaseous*, and gradually condensed as they cooled, till, at a certain stage of the process, they were composed of incandescent fluids, surrounded by a thin crust of matter that had parted with sufficient heat to assume the solid form. Those remarkable bodies, the *nebulæ*, of which Mr. Webb discourses so admirably, were imagined to be worlds in this incipient or gaseous stage, and when the telescope resolved some of them into hosts of remote and widely-separated stars, bad reasoners in science said the nebular theory was overturned, although it was not at all affected by the splendid discovery that had thus been made. *How* our earth passed from earlier stages to its present form we do not know, nor can we tell what those stages were. If, however, the nebular theory had been proved, it would not have necessarily followed that our earth had made such slight advances towards solidification as to be a mere shell with fluid contents. More complete research shows that we know only an infinitesimal portion of the earth's past history, and that its present condition is that of a very strong and solid globe. Mr. Hopkins long ago showed, by mathematical investigation, that the earth-crust could not be less than eight

hundred miles thick, and Professor Wm. Thompson, making independent calculations from another class of well-ascertained facts, concludes that it must be as thick as half its radius, and thus the notion of its being a bottle full of fiery fluid is definitively dispelled.

What, then, is an earthquake? It would seem to be a concussion given to a portion of the earth at a certain depth below the surface by forces of an igneous kind. A sudden heating and expansion, a sudden irruption into a place where there was no room for it, of a fluid or gaseous matter, would, so to speak, give a thump in *all* directions to surrounding substances. The particles struck would hand on the blow, just as one billiard-ball transmits it to another, and some of the waves of this concussion would make their way towards the surface, and emerge at a certain angle, capable of being observed.

Until a very recent period no one thought of applying the principles of mechanics to the elucidation of the phenomena of earthquakes, and to Mr. Mallet belongs the chief credit of the great advance that has been made in the methods of observing and interpreting the effects they produce. His great work on *Observational Seismology** is the authority to which all students must refer, and as it is comparatively little known outside a limited circle of scientific men, we propose to resume the subjects of earthquakes in our next number, and to do our best to present a difficult and very technical subject in a popular form. To many minds the name Seismology will be as alarming as an earthquake itself. The meaning of the word will, however, be at once apparent to the Greek scholar, as it is derived from *seismos*, a concussion, and *logos*, a discourse; and if we followed the good fashion of the Germans in inventing vernacular names, we might convert all the "ologies" into "talk-abouts," or "lores," and Seismology would be "shock talk-about," or "shock-lore"—a dissertation on concussions and their effects.

Mr. Mallet's work *ought* to be found in the library of every scientific institution, and in all other public libraries that make any pretence to further intellectual pursuits. It belongs to a class of richly illustrated books of high practical value, which are necessarily too expensive for most private students to purchase in any quantity, but which must be made accessible, if the higher branches of education are to progress.

* *The First Principles of Observational Seismology*, as Developed in the Report to the Royal Society of London, of the Expedition made by command of the Society into the interior of the Kingdom of Naples, to investigate the circumstances of the great Earthquake of December, 1857, by Robert Mallet, C.E., F.R.S., F.G.S, M.R.I.A., etc., etc. Published by the authority and with the aid of the Royal Society of London. 2 vols. 8vo. *Chapman and Hall.*

It is highly important to bring earthquake phenomena within the domain of exact science, because it is evident that they arise from agencies that play an important part in preserving the *stability* of our globe, which does not result from *quiescence*; a condition unknown to nature, but from the balance of forces operating in various directions. No portion of the earth is *still;* all is subject to actions of degradation and reparation, levelling and elevation, and were earthquakes and their causes to disappear, the result would be eminently destructive to the system as a whole. These facts will appear more plainly when we proceed to expound the elements of the new science of Seismology, and although a great deal remains to be done before that science can reach its maturity, it is already entitled to no inconsiderable rank among the various branches of physical investigation. Not only must we consider earthquakes and volcanic eruptions with which they are associated as belonging to the regular and methodical sequence of terrestrial changes, but we have already some inklings of their being in some way connected with the system of which we form a part. In fact, all phenomena of light, heat, electricity, magnetism, and mechanical impulse are correlated to each other, and more or less dependent upon solar influence, and other causes of a cosmic kind.

The action of volcanoes is plainly connected with heat, and earthquakes must, according to the Seismological philosophers, be considered to belong to the same category of phenomena. "An earthquake in a non-volcanic region," says the British Association *Catalogue*, "may, in fact, be viewed as an uncompleted effort to establish a volcano. The forces and impulse are the same in both; they differ only in degree of energy, or in the varying sorts and degrees of resistance opposed to them." These considerations give an additional interest to the investigation of the products of volcanic action, because the nature and condition of the gaseous and solid materials ejected from craters in eruption may afford some clue to those subterranean conditions of matter under which the disturbance was produced.

The study of earthquakes and volcanoes may lead to our acquiring some knowledge of the changes that take place below the surface of the globe; but, except in an indirect manner, they are not likely to bring us information from *great depths*, as the focus of disturbance in the best examined cases has not been found to lie far below the surface.

From Mr. Milne's tables, it appears that the period of the year in which earthquake action is most abundant is when both the actual height of the barometric column is the minimum, and the range of its oscillations the greatest. The atmospheric

changes made known to us by the barometer indicate an enormous difference of pressure where great areas are concerned, and this, together with the marked variations in rainfall that accompany oscillations of the barometric column, may well be supposed to exercise a powerful influence on the less stable portions of the crust of the earth.

But these atmospheric changes are dependent upon causes partly terrestrial and partly cosmic, of which the rotation of the earth and solar heat may be considered as the chief. We must also recognize the probable influence of the moon, known to be so great in the production of oceanic tides, and, as would appear from the analysis of earthquake catalogues by M. Alexis Perry, in some way ancillary to the promotion of concussions and oscillations in the strata of our globe.*

LITERARY NOTICES.

A History of the Fishes of the British Islands, by Jonathan Couch, F.L.S. Vol. II. *Groombridge.*—The second volume of Mr. Couch's valuable work contains an account of seventy-four fishes, and is illustrated by sixty-three of those accurately-drawn and beautifully-coloured plates which are better than all descriptions for purposes of instruction, or identification, and at the same time produce a highly artistic and ornamental effect. Many fishes of great interest are described in this volume, such as the Gurnards, remarkable for brilliant colouring and for possessing highly-developed air bladders, that, in some species at least, are capable of producing vocal sounds. Mr. Couch tells us that the air bladder of this family vary in shape according to the species, but all are firm in texture, and have muscular fibres interwoven in their fibrous tissue. The reader will recollect that in our first vol. (p. 324), under the head of "Vocal Fishes," there is an account of Dr. Dufosse's researches, in which he ascribes the sounds produced by the Gurnards and Dories to the vibration of these muscles. We have also an account of the Opah and the Bergylt, which live at great depths,

* The *Tenby Observer* mentions a curious phenomenon that may be connected with the late earthquake, having occurred on the same day. It was seen in Carmarthen Bay, and the account states, that—"From a base extending some three or four miles in the direction of Amroth Castle an immense piece of water, of a dark brown colour, as if holding earth in solution, seemed to be pushed forward in the form of a cone, of course surrounded by water of a natural colour. It steadily advanced in the same form towards Monkstone, and thence some miles to sea. Some friends in amusing themselves with fishing were not a little startled by the strange sight. When the coloured water overtook the boat they found that the point of division between the colouring was maintained throughout the depth of the water; the boat was violently pitched about, and the water thrown completely over it. It was observed first at about eleven a.m."

where the pressure must be enormous, the temperature very cool, and the quantity of light excessively small, and which nevertheless glow with magnificent tints, popularly imagined to be peculiar to regions that are exposed to the warmth and illumination of a tropical sun. The Goby family likewise supply much interesting matter, which the possessors of aquariums will appreciate, as some of the Gobies are among the most elegant of their captives. The Remoras and Sucking Fishes also occur in our list, and the Shanny, which climbs out of the water and basks on a sunny rock. Mr. Couch kept one of these fishes for six months, and he tells us that in the summer it would lie for hours together on a stone, and passed half its time out of water. Cooler weather induced it to remain in the liquid element under shelter of a stone. Reading these and similar instances shows us that a "fish out of water" may be an image of enjoyment as well as of discomfort, and facts of this kind bridge over the gulf that separates the atmospheric from the aquatic tribes. It should, however, be remarked, that fishes which can live for a time in air keep their gills moist, and are furnished with a slimy varnish that arrests evaporation from their skin. This volume cannot fail to enhance the great popularity which has hitherto attended Mr. Couch's scientific and praiseworthy labours.

A MANUAL OF POPULAR PHYSIOLOGY, being an attempt to Explain the Science of Life in untechnical Language, by HENRY LAWSON, M.D., Professor of Physiology in Queen's College, Birmingham, etc.—*Hardwicke.* Professor Lawson is an able physiologist, and, as our readers know by the excellent papers from his pen that have appeared in our pages, he possesses in a high degree the art of presenting a difficult subject in a clear and interesting light. This little volume bears obvious marks of extensive knowledge, and capacity for imparting it; but while we praise it for its excellent qualities, we must be permitted to regret that its author did not implicitly trust to his subject and to his own natural talent in dealing with it. The incongruous matter frequently introduced for the sake of amusing the reader, will in many cases have an opposite effect, and tend to divert attention from the substantial merit of the work.

A DESCRIPTION OF CERTAIN DRY PROCESSES IN PHOTOGRAPHY, specially adapted to the use of the tourist, by GEORGE KEMP, M.D. *Davies, London: Greenwood, Liverpool.*—This little book is not adapted to beginners in photography, and those who have had experience will only care to read certain portions that may be new to them. We extract one paragraph that may be useful to some of our microscopic readers. "Take, for instance, the very beautiful ciliary processes of the *Balanus porcatus*—the common rock barnacle of our coasts—and arrange them on a small plate of glass; with careful washing all the salt water and its solutions may be removed; the whole should be placed in a slow oven, or under the receiver of an air-pump, to dry, and then a few drops of moderately thin uniodized and freshly-prepared collodion poured over the specimen. This, when dry, may be floated off the plate into a vessel of clear

water, with four or five drops of glacial acetic acid, and when sufficiently washed and dried, be appropriately trimmed and mounted for the microscope."

ON THE METHOD OF OBSERVING VARIABLE STARS, by GEORGE KNOTT, LL.D. Lond., F.R.A.S., and JOSEPH BAXENDELL, F.R.A.S., etc. Printed for private circulation. In a former number we mentioned the formation of a "Variable Star Committee," whose special function is to watch and collect information concerning variable stars; and we likewise published a short paper by Mr. Knott,* explaining the method to be adopted in these curious and important investigations. The pamphlet now before us conveys more detailed information on the same point. The writers recommend the magnitude of stars to be determined according to the plan of the Rev. R. Dawes, by ascertaining the exact amount of aperture at which they cease to be visible, and they supply examples of the mode of comparing one star with another, of estimating the difference between them, and of recording the observations. We presume that this pamphlet may be obtained on application to Mr. Knott, Woodcroft Observatory, Cuckfield, or to Mr. Joseph Baxendell, Manchester; but we should have thought it better that the Variable Star Committee should have issued it as their official code of directions. There can be no doubt that the observation of variable stars, and an accurate register of their increase and decrease of brilliance, and of the exact time occupied in such changes, is calculated to throw much light upon obscure but very interesting questions of stellar astronomy; and it is a work in which private students may successfully engage, as it will not require the costly apparatus of a regular observatory, nor make extravagant demands upon their knowledge and skill. It is, however, a kind of labour in which systematic co-operation is of great advantage, and we recommend that all who are disposed to engage in it, should at once put themselves in communication with Mr. Knott and Mr. Baxendell.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At the recent meeting of the British Association several examples were brought forward demonstrating the direct bearing of scientific researches upon the advance of medical science. No sooner is any new substance (whether an elementary body, such as thallium, or a compound) discovered, than experiments are made to investigate its physiological and therapeutical action on the living organisms of men and animals. In many cases these experiments are made by the observers on their own bodies, and the records of science offer

* See INTELLECTUAL OBSERVER, April, 1863, p. 212.

several examples of enthusiastic investigators whose lives have been perilled by the self-administration of dangerous re-agents.

As a rule, these investigations are made, in the first instance, on the lower animals: but the results so obtained only give a very slight approximation to what would be the nature of the action of these bodies on the human frame.

We know absolutely nothing of the different constitutional powers in the different animals, so that our only means of acquiring a knowledge of the therapeutical action of remedies is by direct experiment in every case.

For example, the goat and the sheep are so slightly different in structure and organization that it is difficult even to discover a well-defined specific distinction between the two animals. Nevertheless, many substances are fatal to the sheep that the goat eats with impunity. A goat will eat at a meal a sufficient quantity of laurel twigs (*Cerasus Lauro cerasus*) to destroy the life of a cow, a ruminating animal, whose organization closely resembles its own. In the same manner, tobacco—one of the most fatal of all poisons to the human frame—is eaten by goats and monkeys with great avidity, and without any apparent evil consequences.

Among the most important new remedies which science has bestowed upon medicine may be mentioned the preparations of the element bromine.

Bromine, as is well known, belongs to the same group of elements as chlorine, iodine, and fluorine; each of these, though perfectly capable of replacing each other in chemical combinations, has a totally different action on the vital organism.

Chlorine is an essential to the life of all animals, and is supplied in the form of common salt, chloride of sodium. Iodine is, both when simple and in combination, a powerful stimulant, exciting the glandular system.

Fluorine, though never yet isolated, is in some of its combinations a powerful poison.

Bromine has been discovered by Dr. Gibb to possess, when administered in the form of bromide of ammonium, Br N H_4, a power of producing insensibility or even partial paralysis of the nerves going to the glottis and larynx, or organs situated at the top of the windpipe.

This knowledge has been at once applied to practical medicine. The painful disease known as whooping-cough owes its chief danger and discomfort to spasm of the nerves going to the respiratory organs. It has been found that the administration of a few grains of bromide of ammonium three times a day has the effect of allaying this spasm, and so preventing the most dreaded symptoms of the disease.

Having alluded to the newly-discovered metal, thallium, it may be as well to mention that M. Lamy states that continued investigation into its properties has resulted in extreme lassitude and pain in the lower limbs. With a view of determining its real influence on the animal economy, he has administered it to the lower animals, and he mentions that a decigramme of the sulphate given to a dog

has caused death in forty hours. Mr. Crookes, on the other hand, denies its power, and states that he has occasionally swallowed a few grains of its salts without injurious effect.

Mr. Crookes' further researches on Thallium have brought forward several points of great interest. In testing for thallium in the flue-dust of pyrite burners, he finds that the spectrum analysis is useless from its extreme delicacy; $\frac{1}{1000}$ part of thallium in a mass being indicated as strongly and vividly as the pure metal itself.

Mr. Crookes has been experimenting upon several tons of this dust. The most ready method of extraction he finds to consist in washing it with pure water, accidulating the liquid with hydrochloric acid, so as to convert the thallium into chloride. In this manner he has obtained from three tons of flue-dust sixty-eight pounds of impure chloride, which was afterwards converted into sulphate by heating with sulphuric acid; this conversion into chloride and reconversion into sulphate being repeated, in order to get rid of impurities. Finally, the sulphate was reduced to the metallic state by fusing with blax flux or with cyanide of potassium. Thallium melts at 550° Fahr., and can consequently be easily fused over a gas jet, its surface being protected from the air by a stream of coal-gas.

Mr. Crookes exhibited a mass weighing upwards of a quarter of a hundredweight, and demonstrated its more obvious properties. It is the softest of the non-alkaline metals, being easily scratched by a point of lead. When obtained in larger quantity, thallium will doubtless be employed to furnish a magnificent green flame. Eight parts of chlorate of thallium, two of calomel, and one of resin yields a splendid light on being ignited, and a very little reduction in price would enable it to be used for ship-signals; its extraordinary intensity and monochromatic character enabling it to penetrate through a hazy atmosphere, which alters altogether the colour of the ordinary green lights produced by the salts of baryta.

SOCIAL SCIENCE CONGRESS.

Alleged Elevation of the Coast Line of the Lothians.—On the occasion of the members of the Social Science Congress visiting the Bass Rock, in the Firth of Forth, Mr. Bryson described the geology of the district, particularly with reference to the alleged rise of the coast line of the Lothians—one of the circumstances from which Sir Charles Lyell has adduced an argument in support of his views on the antiquity of man. Mr. Bryson maintained that no violent upheaval had taken place, but that the deposit on the shores of the Firth had been caused by a great wave of translation, which had thrown up the various marine remains that are now to be found far elevated above the water line along the coast.

ENTOMOLOGICAL SOCIETY.—*Oct.* 5.

Destructive Habits of Larvæ of Noctua segetum.—The importance of study of practical entomology was evidenced by Mr. S.

Saunders, who described the ravages of the larvæ of the *Noctua segetum* on the young of Swede turnips. Many acres of this important crop had been destroyed by these grubs, which, attacking only that portion of the root below the surface of the earth, were protected from the action of any ordinary remedy. Mr. Saunders suggested that the only probable remedy would be the destruction of the eggs of the moth before hatching. Mr. Stainton described the singular situation of the pupæ of the *Tortrix grandævana*. The larvæ of this insect feeds on the roots of the common coltsfoot, on the shores of the Baltic, and subsequently forms tubes the size of the finger in the sand, turning to pupæ in these tubes. Frequently the loose surrounding sand is blown away, when the exposed tubes are opened by birds, who devour the insect.

NOTES AND MEMORANDA.

Thunderstorms and the Moon.—M. Bernardin calls the attention of the Belgian Academy to the fact that many thunderstorms have occurred about the period of the new or full moon, and he invites inquiry for the purpose of ascertaining whether there is any connection between the movements of our satellite and the electrical condition of the atmosphere.

Artificial Fecundation of Plants.—The *Moniteur* has published an account of the process of M. Hooibrenck, which is reported to increase the fertility of cereal and other plants. When the grain is in flower, he passes over it an apparatus consisting of a string set with tufts of wool, close together, and having small lead weights between them. He repeats this brushing of the flowers three times, at intervals of two days. Espalier fruit trees he deals with in another fashion. First, he touches the stigmata with a finger carrying a little honey, and then brushes the flowers lightly with a powder-puff. By this means pollen is brought into contact with the honey, and adheres. Larger trees he reaches with a sort of brush, composed of tufts of wool. A commission appointed by the Minister of Agriculture reports very favourably upon these processes, as increasing the yield of corn, and they observe, that the fruit trees operated on produced an abundant crop, but they could not so easily satisfy themselves to what cause it was due. The Emperor has directed that these and other experiments of M. Hooibrenck shall be repeated on two of the imperial farms.

Effects of Belladonna.—In the month of September we saw a magnificent specimen of the Deadly Nightshade, *Atropa belladonna*, growing in a chalk dell in Hertfordshire, near Wheathampstead. It formed a splendid bush, spreading out on all sides, the stems five or six feet long, and the berries quite as large as small damsons. Shortly afterwards, the plant was visited by a young lady, accompanied by a gentleman, who cut a branch, which she held while he cut some more, and then walked away with the branch in her hand. In a few minutes she felt uneasy, and shortly afterwards was seized with violent headache, giddiness, and nausea. These symptoms continued for the rest of the day, through the night, and through the following day, when her eyes were very heavy, and she found herself unable to walk on account of the giddiness. On the third day the headache was better, but pain in the side had come on, and considerable debility. Six days after the first attack, the headache and sickness began to return, but were removed by a little brandy and water. The pain in the side did not cease till some days later. These facts indicate the great caution that should be used in dealing with this remarkable poison, to the influence of which some constitutions are peculiarly sensitive.

Novelty in Cattle Breeding. The *Archives des Sciences*, for September,

1863, contains a communication from a Swiss agriculturist, stating, that in February, 1861, he received from Professor Thury, of Geneva, a letter containing confidential instructions, which he was to carry out for the purpose of experimentally verifying an assumed law regulating the production of the sexes among animals. The result was, that in twenty-two successive cases, females were obtained, according to desire. The animals bred from, were Swiss cows and a Durham bull. M. Cornaz then purchased a Durham cow, and desired to procure, by breeding, a Durham bull, in which he succeeded. He also desired to breed six bulls, crossed between Durham and Schwitz, and by selecting cows of the colour and height he wanted, he was again successful, and regards Professor Thury's method as of the highest importance to breeders of cattle.

The law enunciated by Professor Thury, and confirmed by M. Cornaz, is, that sex depends on the degree of maturation of the egg at the moment of fecundation. In uniparous animals, fecundation at the commencement of the rutting period gives females, at its termination, males. In multiparous creatures, the first eggs that descend from the ovary generally give females, the last males; but M. Thury says, that in a second generative period that succeeds the first, circumstances are considerably changed, and the last eggs give females. Many of our rural readers, engaged in agriculture, will be able to verify these curious statements, which may have an important influence on the profits of farming.

New Metal.—M. M. Reich and Ritter have discovered a metal distinguished in the spectroscope by an indigo blue ray, and which they call *Indium*. They obtained it from a composite mineral, chiefly composed of sulphur, arsenic, iron, and lead.

New Planet, 79th.—We learn from the *Astronomiche Nachrichten*, that Mr. James Watson, of Ann-Arbor, U.S., has discovered a new planet of the 9·3 magnitude. It was seen by Oppolzen in Vienna on 6th October.

Mr. H. J. Carter on Rhizopods.—In *Annals of Natural History* this gentleman states that he has demonstrated the existence of chlorophyll cells in the body of *Difflugia pyriformis* as part of its organization. Starch granules, he affirms, form "part of its products," and he states that the tests conjugate. These circumstances, he considers, show the strong alliance between the Rhizopods, which he regards as *animals*, and the vegetable kingdom. He likewise describes a new Rhizopod, found in bog water, on the south coast of Devon. It is "globular, subround, green, loricated, spiniferous, and tentaculiferous. Spines straight, hollow, of uniform breadth in the shaft, bifid, or forked, at the distal, and discoid at the proximal extremity; very numerous, apparently rigid, radiating, or turned across each other, and moveable, as the spines in Echinus." Lorica, 1-411", species, 1-740" long.

Sunlight Illumination for the Microscope.—Mr. Wenham states, in *Quarterly Journal of Microscopical Science*, that fine markings on objects may be seen by placing the microscope in strong sunlight, and employing the concave mirror, and an achromatic condenser of large aperture. The eye could not support this blaze without protection, but by placing the red and green glasses of a sextant over the eye-piece, it was toned down, and the markings on all the most difficult tests easily and quickly brought out with remarkable distinctness.

Dry Mounting for Microscopic Objects—Mr. T. S. Ralph, of Melbourne, communicates to the *Quarterly Journal of Microscopical Science* his mode of mounting certain objects. He punches rings out of thin gutta percha. One of these rings is placed on a glass slide, and the object arranged in the centre. A covering glass is then placed on the ring, the slide made warm to soften the gutta percha, and gentle pressure applied, by which it is made to adhere to both glasses. The edge of the cover is finally varnished.

Use of Dead Sea-water.—M. Roux has laid before the French Academy an analysis of this water, which shows that, in addition to considerable quantities of chlorides of magnesium, sodium, calcicum, and potassium, it contains bromide of magnesium to the extent of 0·364 grammes in 100'000 grammes. M. Roux considers that it may prove a very valuable medicine in scrofulous, syphillitic, and many other affections. Shall we have this locality converted into a fashionable

watering-place, and find dead sea-water figuring amongst the articles of our import trade. It is evident that if bromides come into greater demand for photographic, medical, and other purposes, they might be economically prepared on this spot, at least to the extent of evaporating the water in shallow basins by natural heat, and sending the solid residue to our laboratories for further manipulation.

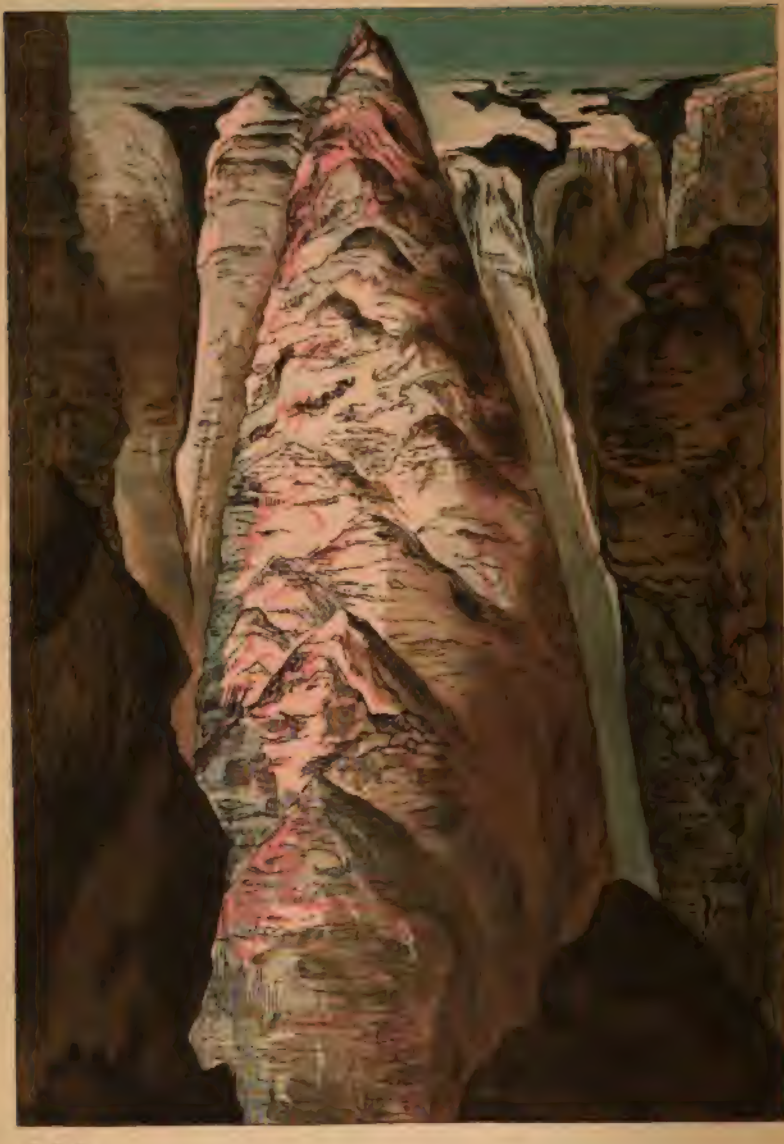
THE COMPOSITION OF OZONE.—*Comptes Rendus*, No. 14, 1863, contains an important paper on ozone by M. J. L. Soret, presented to the French Academy by M. Regnault, in which, amongst other facts, he states that if ozone is destroyed by heat, by bringing a platina spiral passed up into a globe containing ozonised oxygen to a dull red heat, the volume of oxygen is considerably increased, while a very slight increase takes place in oxygen that has not been ozonized. For this and other reasons, the writer regards ozone as composed of more than two atoms of oxygen. M. Soret observes that many chemists regard oxygen in its ordinary gaseous state as composed of two atoms, OO, and he says we may conceive molecules of ozone to consist of three atoms of oxygen, OOO, and to constitute a binoxide of oxygen. He thinks it may contain more than three atoms of oxygen, but to determine the exact number its density should be known.

INFUSORIA AND GERMINATION.—M. J. Lemaire states in a note to the French Academy that if powdered porcelain is placed over a mass of moistened beans, barley, or oats, bacteriums make their appearance in about twenty hours, and vibrions and monads in forty-eight hours. The porcelain fragments may be made red hot, and the distilled water used without changing this result. Phenic acid stops both the production of infusoria and the germination. If the acid is removed, the infusoria appear, and the seeds germinate.

NOVEL CASE OF MARINE PHOSPHORESCENCE.—M. Morellet informs the French Academy that after taking a sea-bath near Penols, Herault, the bathing dress he wore, and that of his companion, were rinsed in the sea-water, and placed in a basket, where they remained till nine P.M., at which time they were taken out, and emitted sparks when touched. Three days afterwards he repeated his bath, but the clothes were not affected. The first bath took place in August on a hot day.

BEAUTIFUL POLARISCOPE OBJECT.—F. R. Martin informs us that if the beautifully crystallizable compound called "Santonine" (which is obtained from *Artemisia contra*), is dissolved in chloroform, and a little of the solution placed on a slide, and very gradually evaporated over a spirit-lamp, it will be observed, on making starting points for crystals with a fine needle, to form into beautiful satin-like rosettes, making a magnificent object for the polariscope, similar to the well-known Salicine slides.

VOLPICELLI ON SPECTRAL ANALYSIS.—According to *Cosmos*, this observer states that "when solar light traverses our atmosphere, the rays appear in the same number and intensity, whether the air be dry or moist. This result accords with the ideas of M. Janssen, who attributes the telluric rays in the spectrum to the obliquity of the coincidence of the solar rays, and not to the influence of vapour of water. M. Volpicelli caused the solar rays to traverse an oxyhydrogen flame, the primitive atmosphere being dry; the telluric rays were not augmented in number or intensity." He concludes, in opposition to Secchi, "that the vapour of water is not the principal cause of the formation of the telluric rays."



G. E. R.

Tower of the Cañon on the Colorado River.

THE INTELLECTUAL OBSERVER.

DECEMBER, 1863.

THE GREAT CAÑONS OF THE COLORADO RIVER.

BY GEORGE E. ROBERTS.

(*With a Coloured Plate.*)

THE nautical enterprise undertaken in 1857-8 by Lieutenant St. Ives, at the command of the American Government, to ascertain the navigability of the Colorado River of the West has been productive of high scientific results, as well as successful in its more immediate object of opening an economical avenue for the transportation of supplies to military posts in New Mexico and Utah. The memoir of the expedition, published by the War Department of the United States in 1861, has not received the attention in this country which its merit deserves, and which it fairly claims from all geographers and geologists. The enormous difficulties which beset the course of the explorers after the navigable, or lower portion of the Colorado River had been passed, render it extremely unlikely that any second party will ever penetrate into the inhospitable, but marvellously beautiful country, which headed off all their attempts at progression. "Ours has been the first, and will, doubtless, be the last party of whites to visit it," writes the leader of the exploring band. "Everywhere our reconnoitring parties have been stopped by impassable obstacles. It seems intended by Nature that the Colorado River, along the greater portion of its lonely and majestic way, shall be for ever unvisited and undisturbed." Arid table-lands, channeled in every conceivable direction with the deepest and most dismal abysses existing upon earth; tenantless, both by Indian tribes and by animals and birds, for even those which inhabit the surrounding territories seem to have deserted it, down to the smallest reptile; without water— "a more frightfully arid region probably does not exist upon the face of the earth;" and, as a natural consequent, almost without vegetation; the territory which shuts in the rise of the Colorado

River has no inviting prospect for the colonist, or charm for any traveller, save an arduous pursuer of the wildest scenery.

The characteristic of its scenery is a series of cañons, or deep precipitous passes, through which the river winds, and these increase in height and sublimity towards the north, until the rise of the river is traced to gorges in the Rocky Mountains, the almost perpendicular walls of which measure over a mile in height. The Colorado River is, with one exception, the largest stream which flows from American territory into the Pacific Ocean. Very little has been known till lately concerning its course and the grandeur of the near-lying scenery; though, singularly enough, some portions of it were among the earliest parts of America explored. In less than fifty years after the landing of Columbus, Spanish missionaries and soldiers were travelling upon it, following its course for a long way from the mouth, and even attaining one of the most distant and inaccessible points of its upper waters, for one Captain Cardinas reported in 1540 that he had arrived, guided by Indians, at a part of the river where "the banks were so high that they seemed to be three or four leagues in the air." This is the first notice of the famous Big Cañon of the Colorado.

The record of the Government exploring party is set out with so many scenic observations that we seem scarcely to need the help of the many views, maps, and charts which illustrate it, to aid our realization of their voyage.

Starting from the mouth of the river in the Gulf of California, a foretaste of glorious scenery to come was given by a powerful mirage, converting the outlines of distant hills into fanciful shapes of castles, domes, and giant statues, painted with glowing purple tints and sharply-defined tracery on the blue background of the sky. Beyond the mouth, glittering islands broke up the monotony of the broad stream, and green lawns, on which myriads of pelicans were congregated, sloped down to the water's edge. A few miles from the mouth the phenomenon of a tidal "bore" was discovered: a single immense wave, which rises to the height of ten or twelve feet, and ascends for many miles up the current; an analogous phenomenon to the well-known one which occurs at high tides near the confluence of the Severn with the Bristol Channel. From the mouth to the pass of the Purple Hills, a distance of 450 miles, the scenery did not call for special remark, but from that point began the wonders of the river. Sailing past a range of chocolate-coloured mountains, and through a gateway formed by a huge crag of vivid red rock, they reached the Monument Mountains, and the first of the great series of cañons which were in future to hem in their course.

"Immediately above the river grew narrower and deeper, and the hills crowded closely upon the water's edge. The regular slopes gradually gave place to rough and confused masses of rock, and the scenery at every instant became wilder and more romantic. New and surprising effects of colouring added to the beauty of the vista. In the foreground, light and delicate tints predominated, and broad surfaces of lilac, pearl-colour, pink, and white, contrasted strongly with the sombre masses piled up behind. In their very midst a single pile of a vivid blood-red rose in isolated prominence. A few miles higher a narrow gateway opened into the heart of the mountains. On one side of the entrance was a dark-red column; on the other a leaning tower of the same colour overhung the pass, the ponderous rocks seeming ready to fall as we passed beneath. Rich hues of blue, green, and purple, relieved here and there by veins of pink and white, were blended in brilliant confusion upon the sides of the cañon, producing a weird-like and unearthly effect, which the fantastic shapes and outlines of the enclosing walls did not diminish. For six miles we followed the windings of the river through this fairy-like pass, where every turn varied and heightened the interest of the pageant, and then the lines of cliffs stopped, and we issued suddenly from the cañon into a comparatively open valley."

Beyond this they came to the still more wonderful cañon through the Mojave Mountains:—

"A low purple gateway and splendid corridor, with massive red walls, formed its entrance. At the head of this avenue, frowning mountains, piled one above the other, seemed to block the way. An abrupt turn at the base of the apparent barrier revealed a cavern-like approach to the profound chasm beyond. A scene of such imposing grandeur as that which now presented itself I have never before witnessed. On either side majestic cliffs, hundreds of feet in height, rose perpendicularly from the water. As the river wound through the narrow enclosure, every turn developed some sublime effect or startling novelty in the view.

"Brilliant tints of purple, green, brown, red, and white illuminated the stupendous surface, and relieved their sombre monotony. Far above, clear and distinct upon the narrow strip of sky, turrets, spires, jagged statue-like peaks, and grotesque pinnacles overlooked the deep abyss."

Beyond this defile was the great valley of the Mojaves.

"Our proximity to it was soon announced by a lofty column of smoke that ascended from the summit of a little peak near the bank, where a watcher had been stationed to warn the inhabitants above of our approach. In a few moments a gap in the side hills revealed a glimpse of an open country,

with bright foliage and green trees, and a blue range in the distance, and after traversing a short avenue, lined with low bluffs, and terminated by a narrow gateway, we issued from the hills and beheld the broad and noble valley of the Mojaves stretched before us."

One out of several smaller cañons through which they afterwards passed had some charming features of its own:—

"It was only two or three miles in extent, and the sides were of moderate height, but the gorgeous contrast and intensity of colour exhibited on the rocks exceeded in beauty anything that had been witnessed of a similar character. Various and vivid tints of blue, brown, white, purple, and crimson were blended with exquisite shading upon the gateway and inner walls, producing effects so novel and surprising as to make the cañon in some respects the most picturesque and striking of any of these wonderful mountain passes."

But the "Black Cañon" outvied all its predecessors:—

"In a few minutes, having passed what may be called the outworks of the range, we fairly entered its gigantic precincts, and commenced to tread the mazes of a cañon far exceeding in vastness any that had yet been traversed. The walls were perpendicular, and more than double the height of those in the Mojave Mountains, rising in many places sheer from the water for over a thousand feet. The naked rocks presented, in lieu of the brilliant tints which had illuminated the sides of the lower passes, an uniform sombre hue, that added much to the solemn and impressive sublimity of the place. The river was narrow and devious, and each turn disclosed new combinations of colossal and fantastic forms, dimly seen in the dizzy heights overhead, or through the sunless depths of the vista beyond.

"There was no need of keeping a watch with two grim lines of sentinels, a thousand feet high, guarding the camp. Even though we could have been seen from the verge of the cliff above, our position was totally inaccessible. Darkness supervened with surprising suddenness. Pall after pall of shade fell, as it were in clouds, upon the deep recesses about us. The line of light, through the opening above, at last became blurred and indistinct, and, save the dull red glare of the camp fire (for here the expedition had landed for the night), all was enveloped in a murky gloom. Soon the narrow belt again brightened as the rays of the moon reached the summits of the mountains. Gazing far upwards upon the edges of the overhanging walls, we witnessed the gradual illumination. A few isolated turrets and pinnacles first appeared in strong relief upon the blue band of the heavens. As the silvery light descended, and fell upon the opposite crest of the abyss, strange and uncouth

shapes seemed to start out, all sparkling and blinking in the light, and to be peering over at us as we lay watching them from the bottom of the profound chasm. The contrast between the vivid glow above and the black obscurity beneath, formed one of the most striking points in the singular picture. As we proceeded, the cañon continued increasing in size and magnificence. No description can convey an idea of the varied and majestic grandeur of this peerless water-way. Wherever the river makes a turn, the entire panorama changes; and one startling novelty after another appears and disappears. Stately façades, august cathedrals, amphitheatres, rotundos, castellated walls, and rows of time-stained ruins, surmounted by every form of tower, minaret, dome, and spire, have been moulded from the Cyclopean masses of rock that form the mighty defile. The solitude, the stillness, the subdued light, and the vastness of every surrounding object, produce an impression of awe that ultimately becomes almost painful. As hour after hour passed, we began to look anxiously ahead for some sign of an outlet from the range, but the declining day brought only fresh piles of mountains, higher, apparently, than any before seen.

"We had made up our minds to pass another night in the cañon, and were searching for a spot large enough to serve as a resting-place, when we came into a narrow passage, between two mammoth peaks, that seemed to be nodding to each other across the stream, and unexpectedly found, at the upper end, the termination of the Black Cañon. These great towers forming the northern gateway were striped with crimson and yellow bands, the gravel bluffs bordering the river exhibited brilliant alternations of the same hues, and not far to the east, mingled with the grey summits, were two brilliant hills, altogether of a blood colour, that imparted a peculiarly ghastly air to the scene. Not a trace of vegetation could be discovered, but the glaring monotony of the rocks was somewhat relieved by these fanciful variations of colouring."

At this point, progress up the river had to be abandoned; the water above being of a shoal nature, the current swift, and the rapids numerous and full of danger. This was, then, the practical head of the Colorado navigation. So the expedition proceeded on mules and on foot to the higher plateaux of the N. W. Rocky Mountains, where they discovered still grander scenery.

From this part we must give an extract or two:—

"At last the ridge of the swell was attained, and a splendid panorama burst suddenly into view. In the foreground were low table hills, intersected by numberless ravines; beyond these a lofty line of bluffs marked the edge of an immense cañon; a wide gap was directly ahead, and through it we beheld, to the

extreme limit of vision, vast plateaux towering one above another thousands of feet in the air, the long horizontal bands broken at intervals by wide and profound abysses, extending a hundred miles to the north, till the deep azure blue faded into a light cerulean tint that blended with the dome of the heavens. The famous Big Cañon was before us; and for a long time we paused in wondering delight, surveying the stupendous formation through which the Colorado and its tributaries break their way."

By dint of much exertion, the elevated plateau was reached, the mighty sides of which formed this stupendous cañon. At a spot near the mouths of Diamond and Cataract rivers, two tributaries of the Colorado, a barometrical observation showed that the almost perpendicular walls of rocks which towered above these streams were over a mile in height! The illustration which accompanies this is a careful reduction of Mr. Egglestein's sketch of one point in this vast river wall.

But the "Big Cañon" was only one of many:—

"The extent and magnitude of the system of cañons in every direction is astounding. The plateau is cut into shreds by these gigantic chasms, and resembles a vast ruin. Belts of country, miles in width, have been swept away, leaving only isolated mountains standing in the gap. Fissures so profound that the eye cannot penetrate their depths, are separated by walls whose thickness one can almost span, and slender spires, which seem tottering on their bases, shoot up thousands of feet from the vaults below."

It may readily be supposed that such a region was but thinly peopled:

"The handful of Indians who inhabit these sequestered retreats, where we discovered them, have probably remained in the same condition and of the same number for centuries. The country could not support a large population, and by some provision of nature they have ceased to multiply. Excepting when the melting snows send their annual torrents through the avenues to the Colorado, conveying with them sound and motion, these dismal abysses, and the arid table-lands that enclose them, are left as they have been for ages, in unbroken solitude and silence."

The exploration of the loftiest of these table-lands nearly proved fatal to the whole party:—

"At the end of ten miles of weary travel, a steep ascent brought us to the summit of a table-land that overlooked the country towards the south for a hundred miles. No place could be descried, far or near, that gave a promise of containing water. The wretched and broken-down animals, now forty-eight hours without drinking, and that, too, while making

long marches under a burning sun, were brought to a halt. They had to be tightly hobbled, for, in their frantic desire for water, nothing else could have restrained them from rushing back to the only place where they were certain of finding it. Too thirsty to graze, they stood all night about the camp, filling the air with distressing cries. This morning, the weakened brutes staggered under their packs as though they were drunk, and their dismal moaning portended a speedy solution of their troubles, should water not soon be found. For the third time the sun rose hot and glaring, and as the great globe of fire mounted the heavens, its rays seemed to burn the brain. The condition of things was desperate, should no water be discovered during the day. A single bad cañon or ravine to turn us from the course for any great distance would be, unquestionably, the destruction of the train."

But, just when matters looked the worst, Heaven sent relief, and men and cattle found life in a pool of clear delicious-tasting water. The lessons in physical geology to be derived from the study of this marvellous district, may well be designated by Dr. Newberry, the naturalist of the enterprise, as of the highest importance. Volcanic action, the sword which cuts so many geological knots, is powerless to account for the formation of these deep, clean-cut fissures, and the isolated fragments of ancient surfaces which overlook them. River action, as exemplified in the downward courses of the Colorado and tributaries from the high table-lands, ten or twelve thousand feet on the west side of the Rocky Mountains, at which they rise, has alone cut into and channeled the district with its wonderful series of cañons. In the lapse of ages, the Colorado has cut its way through the higher plateaux, for at least 500 miles of its course, making deep sections through all the sedimentary strata, and in some cases wearing away hundreds of feet of their granitic base. Thus, in the great cañon of the Colorado "we have the most magnificent gorge, as well as the grandest geological section of which we have any knowledge." The upper Carboniferous limestone forms the top of this section, and beneath it, in natural order, are to be seen the whole of the lower series of that system, with Devonian, and upper and lower Silurian rocks, ending with Potsdam sandstone, resting upon granite, a total exposed depth of 5500 feet!

Dr. Newberry can return no other answer to the question, How came these mighty operations of force to pass? than by referring them unhesitatingly to a system of erosion, to a pure and simple result of water-action.

"Probably nowhere in the world has the action of this agent produced results so surprising, both as regards their magnitude and their peculiar character."

The volcanic rocks were pictures of beauty in arrangement and in colouring.

"Probably nowhere in the world," writes Dr. Newberry, "is there a finer display of rocks of volcanic origin than may be seen about the southern entrance to the Black Cañon. The beetling crags which form its massive portals are composed of dark-brown porphyry of hardest and most resistant character. Just within the cañon, on the west side of the river, this porphyry is mingled with masses of huge, light-brown trachyte; tufa, pure white, or white veined with crimson; and pale blue obsidian (pearlstone); amygdaloids of various kinds, their cavities filled with different zeolites; black and grey basalts, sometimes columnar; scoria, red, orange, green, or black, and of every grade of texture; porphyries in great variety, including some of unequalled beauty; trachytes and tufas of all colours; obsidian in its various forms; all these are abundantly exposed in the immediate vicinity.

"The view from the western slopes of the Black Mountains, which we obtained from the summits bordering the cañon, is scarcely equalled in its savage grandeur by any I have elsewhere seen. A thousand subordinate pinnacles spring from the mountain side, all displaying the ragged outlines which the materials composing them are so prone to assume, while their colours are as striking and varied as their forms. Not a particle of vegetation is visible in the landscape. As the eye of the traveller sweeps over this wilderness of sunburnt summits, which stand so stark and still, glittering in the burning sunlight, and yet so desolate, he shrinks from the unearthly scene with a feeling of depression which must be felt to be imagined."

Many excellent records of exploratory work have been issued by the American Government during the last fifteen years, but the memoir of the Colorado Expedition is the most complete of them all, both in text and illustrative plates, maps and sections.

The certainty that very few English readers will see the original work, and the extraordinary character of the country traversed, will, it is hoped, justify the lengthened extracts that have been made.

THE SUPPLY AND WASTE OF COAL.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

OF all subjects connected with geology, there is not one that possesses more varied interest than coal or mineral fuel. Of its origin and history as a mineral we know little, but that little is extraordinary and unfamiliar, constantly exciting inquiry and attention, and left undecided, notwithstanding the most repeated and the closest investigation. The structure of coal is still a puzzle to the microscopist, to the botanist, and to the geologist. Certainly of organic origin, there is still doubt as to whether some varieties were derived from vegetable or animal life. Certainly vegetable, as much at any rate is, no one has been able to say positively what part was tree vegetation, what was leaf, and what woody tissue, while a good deal may have been once peat-bog, or mere accumulation of sea-weed.

And if the origin of coal is so open to discussion, its geological history is no less so. Who can examine a good natural section in a shaft, or even the rock laid bare by a railway cutting in a coal country, without being struck by the marvellously frequent alternation of seams of coal, shales, and sandstones? A hundred distinct coal seams, of thickness varying from a tenth of an inch to a dozen feet, in a thickness of a thousand feet of strata, is the smallest complication presented to us. In a large majority of the seams it will perhaps be found that rootlets of plants extend down from the coal into a bed of clay below. In others, there will be absolutely no connection of any kind between the coal and the underlying or overlying rock, whether sandstone or shale. Not unfrequently, a band, called a *parting*, of black clay, will be found in the middle of a bed or seam of coal. Now and then the roof or overlying bed of a coal seam is made up entirely of clayey material, in the form of leaves, twigs, and branches of trees, while sometimes a similar appearance will be visible in sands where there is no coal whatever. So much for the association and the mode of accumulation; but what shall we say to the mechanical position in which it is found? In England we are so accustomed in all our coal-fields to find the coal-seams broken and crushed—lifted here out of place; dropped there fifty or a hundred fathoms and lost sight of; re-appearing, where least expected, by another fault; dipping at a high angle in one place, and horizontal in another; the dip considerable, but in the opposite direction, in a third—that we are apt to fancy this to be the normal, or, at least, a necessary condition. An English coal-miner hardly believes that a coal-field can be in proper order without it, and some of our well-meaning but somewhat

hasty writers on this subject have regarded the breaking-up of the coal in this way by fault, as a special and providential arrangement, to bring within range portions of a valuable material which would otherwise have been useless, at least to the present generation. It needs but little knowledge of the coal-fields of other parts of the world to show, in the first place, that vast areas of coal may exist in a workable state, and in the most convenient position, without any faults or fractures at all; secondly, that the faulting is anything but an advantage, even in England; and, thirdly, that the temptation to abuse and waste this valuable material—to throw away more than half the natural supply in order to obtain the remainder at a somewhat earlier period, and at a somewhat cheaper price—has been systematically yielded to by the people supposed to be worthy of this miraculous interposition. Certainly a different distribution of the beds, and a somewhat firmer roof, would have been a simpler and more effectual means of securing a permanent supply.

But without entering into this question, which is not one here to be discussed, there can be no doubt that the extreme complication manifest in the coal measures, the multitude of faults, and the numerous thinnings-out of the seams, as well as the impossibility of identifying beds in distant parts of the country, is connected in an important manner with the general geology of England, and the special structure of the country at the time when the vegetable matter was accumulated, but not at all to the nature of coal itself, or to the removal of coal once formed to a convenient distance from the surface.

The coals of different parts of the world agree in essential characters, but differ so considerably in detail, that no practical difficulty is experienced in distinguishing them. To the uninstructed, there are but three or four recognizable varieties, such as stone-coal, or anthracite, burning without flame; caking-coal, burning with long flame, and cementing into a compact mass as it burns; hard-coal, burning to a white or red powdery ash without caking; and cannel-coal, which does not soil the fingers. Few but those interested in the coal trade, or using coal in large quantities for manufacturing purposes, are aware of the extreme difference in value, and the facility of recognizing the kinds from various localities, or from the several seams of the same mining district.

The points of chief importance in a coal-field, speaking solely with reference to economic value, are the following:— 1. The quality of the coal. 2. The thickness of the seam. 3. The depth at which the workings must be carried on. 4. The nature of the roof and floor. 5. The state of the measures with regard to water. 6. The degree to which the measures

are affected by faults and the dip of the strata. A brief notice concerning each of these conditions will prepare the reader for a consideration of the inquiries suggested by the title of this article, namely the probable extent of the supply of coal in our own country, and the degree of economy exercised in getting and using the mineral fuel.

1. *The quality of the coal.* This depends to some extent on the uses to which it is to be applied, for although all fair coal is usable for most purposes, and saleable, the value differs enormously. Thus an excellent household coal may be but a poor gas coal, and the converse; a good steam coal adapted for locomotives may be indifferent for furnace-work; and so with regard to all. Coals consist of carbon, with a certain admixture of hydrogen, and some oxygen and nitrogen. There is also a certain quantity of siliceous and earthy matter forming the ash. Coals that consist of pure or nearly pure carbon, require so strong a draft to keep up combustion, and give out heat so intensely at a short distance, that they require very peculiar contrivances for using them economically, and thus anthracite, as such coal is called, has but a local reputation. Cannel-coal, again, yielding an enormous quantity of gas, is by no means economical fuel for the open fire of an ordinary grate, or for a steam furnace. The heat is not sufficiently concentrated. Coals yielding a large quantity of ash are, in like manner, undesirable, for much of the caloric produced by combustion is wasted in keeping the earthy ash at a red heat. Thus the value of a coal must be estimated locally, and is strictly relative, though in general no coal could be considered bad in which the quantity of ash is not more than six or seven per cent., and where the per-centage of volatile substances does not exceed twenty-five per cent., and amounts to ten per cent. With less volatile matter than ten per cent. it is anthracite, and with more than twenty-five it passes into cannel coal. In either case the uses are special. Most of the English and Scotch coals are of sufficiently good quality to be available for general purposes, but the money value varies. The Welsh coals are to a large extent anthracites.

2. *Number and thickness of the seams.* Coal exists in beds of all degrees of thickness, from a tenth of an inch to at least fifty yards. It is evident that there must be a practical limit to economic working, and that under certain circumstances it may be expedient and profitable to work seams that under other circumstances could not possibly pay. When worked by shafts in the ordinary way, it is sometimes worth while to remove coal not more than a foot thick; but this is rarely the case, for so much stone and rubbish has to be moved to mine a seam of this thickness, that the work is not profitable. In

most districts, however, a two-foot seam, if of fair quality, and not accompanied by very indifferent roof and floor, can be worked, and thus all seams of two feet and upwards are generally calculated among the available coals of a district.

On the other hand, very thick seams involve waste, especially when the roof above the coal is weak, for then coal, often a foot thick, is left, and ultimately lost. In very thick seams, where the coal is of good quality, the works are often conducted in a very wasteful manner, and thus seams from three to six or eight feet thick are perhaps the most profitable, and those least wastefully worked. The number of workable seams in a coal-field varies exceedingly: in the Newcastle coal-fields it is sixteen, in the Lancashire seventy-five.

3. *Depth of workings.* In most coal districts in England the coal seams, although they may once have approached the surface, have long since been worked out to all small depths, and everything that can be got by horizontal tunnels or drifts into a hill-side has been already removed. Pits or shafts have then to be sunk, at a cost and risk varying according to circumstances, and varying so greatly as to give a character of speculation to coal miuing that would not otherwise belong to it. When the coal measures (the rocks known to belong to the coal-bearing series) are at the surface, or only covered by gravel and soil, the depth of any particular seam can be calculated pretty closely, especially in a district where there are many pits already sunk. Where this is not the case, and rocks of newer geological date have to be pierced, there is, however, great doubt. This arises from the fact that the exposed surface of the coal series, as of other rocks, has been worn down by air and water, and pared off to a great but unknown extent, during the lapse of the ages that have passed away since they were formed; whereas in those cases in which the measures are protected by a newer rock, they have escaped this, and are probably much thicker. There is also in such cases a possibility of disturbances having altered the dip or tilt of the beds, though generally the deeply-covered beds are more likely to be horizontal.

The present limit of workings in coal mines is not much more than 2000 feet. At that depth in England the temperature is already so high as to be inconvenient, and it is at least probable that, at greater depths, it would be still hotter. It has been found possible to work in mines where the temperature is at least fifteen degrees of Fahrenheit higher than in the celebrated Monkwearmouth pit; but this is by slave labour, and might be impracticable in England. At any rate, it is not likely that, even with improved contrivances for lighting and ventilation, a greater depth than from 3000 to 4000 feet will be attained in coal mines.

4. *The roof and floor.* When a continuous bed, or stratum of coal is removed from the mass of the earth, it is as certain that the rest will come together as that the ceiling of a room would fall if the four walls were taken away. By the ordinary mode of mining this is checked for a time, by leaving walls and props of coal, stone, or timber; but the check is only temporary. It is clear that the amount of fracture of the overlying strata will depend on their plasticity and thickness. Thus, a very thick, hard roof of sandstone may, perhaps, squeeze up a soft floor of clay into the spaces between the walls, and any beds of coal in the overlying strata may not be crushed. If, however, there is the smallest irregularity in the sinking, the coal above will be crushed to powder and destroyed. When the roof and floor are both good, the works of a mine may also be carried on more regularly and more profitably than when they are indifferent; and, as in many cases the most valuable seam of a series lies below two or three others that are somewhat inferior, it may happen that the question of the preservation or destruction of these may depend on the nature of the associated beds.

5. *Water.* In almost every coal district a certain quantity of water, draining naturally to the deepest point, will accumulate in the mines, and require removal by artificial means. Every stratum of the coal series that allows water to percolate will act as a channel; and faults, though sometimes they are "close," and cut off the water, in many instances act as conduits, and help to bring into the mine all the rain-fall of a district.

It is evident that, the deeper the mines, the more will they be subjected to this cause of trouble and expense; but, as all the strata cut through in sinking the shafts can be effectually stopped from entering by a water-tight iron casing to the shaft, it is only the quantity brought in by the coal strata themselves that is troublesome. Perhaps it may safely be assumed that improvements in pumping machinery will render this part of the work of mining as easy hereafter in deeper mines as it is now in those already worked.

6. *Faults and the dip of strata.* The main faults in some of the most important British coal-fields are tolerably well known; but there are many, affecting parts of the coal not yet reached, that may prove very serious. The dip of the coal may also render more difficult, though it may make much easier, the working of the deep coal under the New Red Sandstone. There is reason to believe that none of the coal-fields of Europe are really very extensive, and even the adjoining districts in our own island, though but a few score of square miles in extent, are not capable of any exact comparison with one another. On the other hand, the American coal district of Western Virginia is certainly

a very large area, and there are others far larger than our own. Beyond their recognized limits many of the British seams appear to thin out and cease altogether. They have been accumulated on or near small islands, and the circumstances of deposit have not been in all cases the same, neither have they been uniformly affected by the forces employed to depress them in ancient times, and afterwards to elevate them. Some seams are horizontal, some at a moderate dip, and some actually vertical.

The reader will now be in a position to advance one step farther, and estimate the probable amount of the stores of coal sealed up beneath the earth's surface, but accessible to human labour.

Let us see, in the first place, what quantity of coal is contained in a given area. An acre of land contains 2840 square yards, and a square mile 640 acres. Each square yard of coal one foot thick is one-third of a cubic yard, and, as a cubic yard of water weighs about three-quarters of a ton, and coal is about one-fourth heavier than water, each square yard of coal one foot thick must weigh $6\frac{1}{4}$ cwt. A square mile of coal one foot thick will therefore weigh $\frac{2840 \times 640 \times 6\frac{1}{4}}{20} = 568{,}000$ tons. If, then, we can obtain an idea of the average thickness of workable coal, and the area under which it can be worked within certain limits of depth, there is no difficulty in calculating the supply.

A careful measurement of the best geological maps, and a reference to the best sources of information, gives the following result for the British Islands:—

Name of Coal-field.	Estimated area in Square Miles.	Possible extension under newer beds.	Estimated total thickness of seams of workable coal
Newcastle and Durham . . .	460	225	30 ft.
Cumberland, Westmoreland, and West Riding of Yorkshire . .	40	20	15 „
Lancashire, Flintshire, and North Staffordshire	380	150	50 „
Yorkshire, Nottinghamshire, and Derbyshire	750	400	40 „
Shropshire and Worcestershire. .	28	20	27 „
South Staffordshire	100	—	45 „
Warwickshire and Leicestershire .	45	120	30 „
Somersetshire and Gloucestershire .	120	100	60 „
South Wales	900	—	84 „
Scotland	1600	500	54 „

Let us now see what our calculation amounts to, and what are the deductions that cause so much difference of opinion in the estimates of intelligent men. With the same figures before them different writers have come to conclusions so exceedingly different that it is worth while to judge for ourselves.

According to the table there are not less than 4500 square miles of exposed coal measures in Great Britain, and at least 1500 square miles of country where coal may be worked with profit beneath overlying formations. Now, if we assume that the general average of total thickness of seams to be fifty feet, which is probably not very wide of the mark, there will appear to be a grand total of $6000 \times 568{,}000 \times 50 = 170{,}400{,}000{,}000$ tons of coal.

From what has been already said, the following deductions must be made from this amount.

In the estimated area is included the whole district on which all the beds crop out, or are believed to exist under cover. Very much of this is not available, and the actual quantity depends on the dip of the bed, the faults, the depth of the seams, and the mode in which the coal seams are distributed. Thus, in some large areas of coal measures there are no workable seams whatever; in others the difficulty of reaching them renders them valueless. A deduction of fifty per cent. must probably be made on these various accounts, if we would ascertain the available supply.

In the estimated thickness the average is intentionally taken low, but it includes all the workable seams. Now, it rarely happens than more than two or three seams are got. The others are more or less injured, or are for the time neglected, and the resumption of workings in an old colliery to take other seams, at first neglected, is known to be a most dangerous and doubtful speculation. Thus it is practically the case that only a part of the average workable thickness is ever obtained.

Next comes the question of waste. It is impossible for those who are not familiar with coal working to understand how very large and serious a matter this is; but the reader will be prepared to recognize some of the causes.

First: there is the waste from poor coal near the outcrop of the beds. This is now unimportant, as few coals are worked near the crop, but it is a considerable deduction from the estimated quantity. Next: there is the deduction for bad coals near and between faults. In this way large portions of a coal-field are sometimes valueless, inasmuch as they do not pay for working. Thirdly: there is waste from the mode of working. A gallery, or drift, as it is called, is cut in the coal when reached, and other drifts at right angles to this, leaving large square columns, which are smaller or larger, according to the

hardness or tenderness of the coal, and the nature of the roof and floor. On these columns rest the whole weight of the superincumbent rocks—a pressure of a hundred tons to the square foot when the depth is 1000 feet, as is the case in some deep mines. It may well be supposed that this vast weight crushes the coal, and makes it tender. It does not pay to bring up coal-dust to the surface, and thus a large quantity is left behind, besides large parts of the columns that cannot safely be removed. In tender coals the quantity thus lost is very large; the presence of large heaps of small coal, which are often seen burning at the pit mouth, testifies to another cause of waste incident to tender coals, which lose much each time they are turned over.

But these are not the worst causes of waste; there are two others little thought of, but far more serious. The most important is this: thin and poor seams are neglected and destroyed, in order that somewhat better seams a little below may be got first. There could be little objection to this if the seams thus neglected were left uninjured; but this is simply impossible. The descent of the overlying masses into the place of coal worked out always and necessarily involves crushing and fracture of the overlying beds. The coal may not always be, though it often is, broken and rendered powdery, but fissures are opened communicating with the old works, gas and water are introduced, and the seam is partially destroyed. When we see excellent coals three or four feet thick thus utterly and hopelessly destroyed, we are justified in raising a warning cry. This extravagance cannot but have a terrible result; but no one calculates the extent of this loss. To gain a shilling a ton royalty on the coal worked, the proprietor will sacrifice the future interests of his family and the leaseholder his chances of future profits, and thus, where there are twenty feet of workable coal less than ten will be obtained.

The method of working also involves, in many cases, very serious loss; where the coal is thick, and the roof and floor poor or bad, much coal will be left both above and below, and, of course, the whole of this is utterly lost. The large pillars of coal have been alreadymentioned as producing waste, and the utter absence of mining records in most districts where coal is worked, render it so dangerous to approach old workings that thick ribs of good coal are often left between properties, and where the properties are small the proportion thus lost is not trifling.

Lastly: there is waste so serious and so preventible in the use of coal when brought out of the mine that, in this matter alone, a saving might be effected which would, perhaps, double the time that coal will last in this country. The waste of coal

in smoke is as serious a loss as it is a great public nuisance; coal escaping in smoke is absolute waste, for smoke is nothing more than unconsumed fuel. Sir William Armstrong, in his recent address to the members of the British Association at Newcastle, has alluded to this, and has pointed out how wasteful our use is of this important element of national wealth.

After all, then, what is the probable duration of coal in England? The grand total being 170,400 millions of tons, only one-fourth of this can be regarded as in any sense available, after making all the deductions alluded to, and thus the supply is reduced to 42,600 millions of tons. From this must be deducted what has been already used and wasted, and this is a very important part of the whole in several large districts. It is impossible fairly to estimate more than 35,000 millions as remaining; and, since the present calculated consumption approaches a hundred millions of tons per annum, and is steadily increasing, there is nothing unreasonable in the startling conclusion arrived at by Sir W. Armstrong that, if we go on increasing our consumption and not improving our mining, we cannot calculate on any longer period than two or three centuries to exhaust England as a coal-producing country.

That the estimates made some time ago by Mr. Vivian with reference to the South Welsh coal-field, and since repeated, are enormous exaggerations when regarded in any practical sense, there can be little doubt. But neither is it doubtful that, in that great district, if properly worked, the resources are very great. South Wales may, indeed, be soon called on to replace the northern coal-field, which is giving symptoms of partial exhaustion. The Scotch coal-fields, like those of South Wales, are no doubt capable of great development. It is the more necessary that proper economy of working should be insisted on in these exceedingly important and rising districts, if to these we must look for the continuance of our manufactures.

Economy in mining, as well as economy in the use of coal, a careful abstinence from the terrible and suicidal waste that characterises most of our present coal-fields, and a strict and systematic working of these great sources of our country's greatness, are matters so important and so vital as to deserve every attention from our legislators. Coal and iron are the sinews of a great commercial country; with them we have power of every kind, without them it is not easy to see how the British islands could retain a prominent place among the nations of the earth.

SMOKE-RINGS OF VESUVIUS.

BY CHARLES CH. BLACK, M.A.

Having read with pleasure the disquisition on Smoke Rings in No. 16 of The Intellectual Observer, I have thought that your readers might be interested in an account of the production of these phænomena on a large scale. In the years 1845-46, I lived in a villa on the hill of the Infrascata, at Naples, from which a full view of Mount Vesuvius was obtained. My attention had been often drawn to a curious effect in the constantly issuing volume of smoke, resembling somewhat the pine-tree spoken of by Pliny in his well-known description of the awful eruption of A.D. 79, but much more regular and gentle, so to speak, than that fearful crest of vapour. This was simply a thin perpendicular stem crowned by an expanded disc, by no means unlike the "umbrella pine" of Italy, so often used in Turner's foregrounds, but more aptly typified as to proportion by the trivial comparison of a juggler's soup-plate balanced on a long pole. This appearance, so far as I could judge, was never manifested but in a perfectly calm atmosphere, oftenest in the stillness of summer dawn, when I have seen as many as three or four of these smoke stems successively disengaged from the volcano's mouth, sailing slowly landwards, and gradually disappearing in the cloudless sky. These discs I afterwards discovered to be smoke-rings, essentially similar in their formation to those produced either from a cigar, a cannon, or from chemical apparatus, and having a mechanic action precisely similar to that so accurately described by your correspondent. Seen from a distance of five or six miles, and a height of several hundred feet, it is easy to understand that they would present the appearance of solid discs, the edge only being visible. My discovery of their real nature happened as follows :—Accompanied by a friend I was in the habit of rambling about the skirts of Vesuvius, frequently ascending to the edge of the crater, and sketching the fantastic masses of lava with which it was gradually and steadily becoming filled. On these occasions we were never attended by guides, and once, on a hot July day, when quite alone, being seated at different points of the crater, we were surprised by a wild noise in the air. The sound was not unlike that of a steam-whistle, but louder and less regular, dying away gradually directly above our heads. We naturally looked for explanation towards the centre of action; nor were we long disappointed. The mouth of the volcano had for weeks, nay months, thrown out with extreme regularity a small jet of stones every

few minutes, and it now appeared, upon watching the action, that occasionally the subterranean explosion and slight tremor which invariably preceded the jet of molten matter were deadened, and, as it were, muffled. When this was the case, they were followed, not as usual, by a shower of stones, but by a huge globe of smoke, which, hurled upwards to a height of several hundred feet, there exploded, and became a true smoke-ring; the contained gas in its escape producing the wild scream which I have mentioned, and the effect of which in the utter stillness and solitude of a summer noon was somewhat startling. We soon found that a little practice enabled us to discriminate with perfect certainty between the eructations which preceded a discharge of *lapilli*, and those which announced another smoke-ring, and came to the following rough theory as to the volcanic action. It would seem that the gas when generated in Nature's laboratory becomes enveloped in a coating or case of vapour. If this coating be of sufficient density to resist the elastic force of the gas till it reach the external air, a smoke-globe and ring are produced; if, on the contrary, the disruption of the envelope take place within the volcano, the gas encountering the mass of light stones which are continually dancing within the throat of the mountain like a pith or glass ball on a fountain-jet, hurls them upward in its effort to escape. The simile of a pith-ball will appear bold even to ridicule when it is remembered that the projected masses are sometimes, though but rarely, larger than an ordinary house. These, however, are so exceptional, that no one would venture to theorize as to the position they may have occupied previous to their ejection from the fiery gulf; the ordinary *lapilli*, varying in size from a hazel-nut to a cocoa-nut or football, may, under favourable circumstances, be actually seen dancing in a thick crust a few feet below the mouth of the volcano. The inward rotary motion of the various parts of the ring as described by your correspondent was very discernible in these colossal specimens, and may, I think, be thus accounted for. The smoke-globe is first torn asunder in its upper portion by the ascending gas, the lower portion is then rent by the influx of atmospheric air, and this current will, in the act of forming the ring, give to its component particles the spinning motion, not inaptly compared by M. Tegetmeier to a ring of buttons rotating on their *axes*. What atmospheric conditions may be most suitable to the production of smoke-rings I cannot say; but I never saw them except in very calm weather, usually, as above-mentioned, before sunrise; and on the last-described occasion, though it was past mid-day, the usual sea-breeze had failed, and the air was hot and stagnant.

HARROW, *October 28th*, 1863.

THE FIRST JEWISH SHEKELS,

WITH SOME ACCOUNT OF THE SUCCEEDING COINAGES OF JUDÆA, TILL THE REDUCTION OF JERUSALEM TO THE CONDITION OF A ROMAN COLONY, IN THE REIGN OF HADRIAN.

BY H. NOEL HUMPHREYS.

(*With a Tinted Plate.*)

The class of ancient monuments, known as Jewish shekels, closely connected as they are with sacred history, have long formed a very attractive branch of archæological investigation, but till quite recently the researches connected with their study did not tend to very satisfactory results. While numismatic discoveries had led, in the study of Greek and Roman coins, to valuable and striking illustrations of history, and even to the reconstruction of histories that had been lost, all researches connected with the ancient coins of the Jews proved unsatisfactory, and the conclusions eventually accepted by successive archæologists turned out to be more or less incorrect. As an example of the extraordinary results arrived at, in an over-strained anxiety to find important authentications of the sacred history in the curious coins bearing Jewish emblems, it may be stated that learned men of the first class, such as Scaliger, Bochard, and Morin, ignorant of the ancient form of the Hebrew character, thought they could read the names of Solomon, of David, and many others of the Old Testament on the shekels. Kircher at last succeeded in determining on a coin that had been attributed to Samuel, the true inscription, "Simon, prince of Israel," which was as great a step in numismatic palæography of this class, as was Grotefend's first deciphering of the names of Darius and Xerxes in the inscription of Behistun, towards the interpretation of the cuneatic records of Assyria.

Notwithstanding Kircher's successful first step in the right direction, no further advance was made at that time, and, in fact, until the appearance of the beautiful work of Bayer, "On the Ancient Money of the Jews," many of the learned numismatists of the last century were disposed to consider the coins called Jewish shekels as altogether spurious, mere forgeries by dealers, manufactured for the purpose of trading upon the pious credulity of worthy persons deeply interested in every kind of monument seeming to support by material evidence the authenticity of the Holy Scriptures. The work of Bayer, however, combined with the impetus which it gave to further research, indisputably confirmed the authenticity of the ancient coins called Jewish shekels; though, at that time,

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fraudulent imitations were known to be produced by dishonest dealers, as they still are, in considerable numbers.

The general conclusion arrived at with regard to the attribution of these Jewish shekels, after the undoubted proof of the authenticity of genuine specimens, was, that they all belonged to a short period forming the early part of the reign of Simon Maccabæus; he being, it was asserted, the first of the Asmonæan rulers who coined money, in accordance with the concession granted for that purpose by the Syrian king Antiochus VI., after the successful revolt against the Greco-Syrian rule.* The coins bearing the inscriptions, "Simon, prince of Israel," "The first year of the deliverance of Israel," "The second year," etc. etc., seemed to bear out this general view, and many discrepancies were therefore overlooked. For instance, the exceedingly different style of workmanship which distinguished different coins bearing Jewish symbols, was not sufficiently dwelt upon, nor was the weight and size of two or three distinct kinds of silver pieces sufficiently attended to. The first series of suggestions for a reformation of the old classification, was due to the able French archæologist, M. Le Norman; suggestions which M. De Saulcy has since successfully carried out in detail.

The best method of describing the present state of our numismatic knowledge in the attribution of the Jewish series of coins (which are now on all hands allowed to be of unquestionable authenticity) will be to take a summary view of Jewish history from the time of Alexander the Great, about 333 B.C., to the suppression of the Jewish revolt against the power of Rome in the reign of Trajan, about 135 A.D., describing the coins of each period according to the present system of attribution. It is well known that, up to the time of Alexander the Great, the Jews, carrying out in all things the highly conservative character of their constitution, had never adopted the use of *coined* money, but still continued to conduct money transactions by *weighing* the amount of silver paid over in ingots, or smaller pieces, as in the days of the patriarchs. At the period of Alexander's invasion of Asia, the Jews were subject to the kings of Persia, and paid heavy tribute to Darius; but after the battle of Issus, and the signal defeat of the Persian army, Alexander sent a summons to Yaddous, then high priest of Jerusalem, to pay to him the tribute formerly rendered to the Persian king, and also to send him provisions and reinforcements. These demands were refused; probably from a belief that the reverses suffered by the Persian king were only of a temporary nature. But when, after the

* This remark, of course, does not refer to the small later coins belonging to Herod and his race.

taking of Tyre, and then of Gaza, Alexander advanced to the attack of Jerusalem, the local authorities determined to make no resistance, and the chief inhabitants went out to meet him, headed by the high priest, wearing the sacerdotal robes of ceremony. As Josephus* states, Alexander was so much impressed by the venerable aspect of Yaddous, then high priest, that he not only refrained from his intended vengeance, but made a solemn sacrifice on the altar of the temple; and before marching into Egypt, granted to the Jews many privileges and immunities. Among many others may have been that of coining money. This is the more likely, as, previous to the Macedonian invasion, the system of coined money was not generally prevalent in Asia beyond the frontiers of the Greek provinces. The absence of any Asiatic coinage, upon a similar principle to that established by the Greeks, was an inconvenience which Alexander, on penetrating into Asia, at once set about correcting, by causing the treasure acquired in his Asiatic conquests to be coined into money of the Greek form. A vast amount of gold and silver was thus coined; and the staters and tetradrachms then struck were, indeed, so abundant, that they still exist in great numbers, being among the commonest of all ancient coins, and are from their abundance worth little more than the intrinsic value of the metal, except when in very fine preservation. It is, therefore, extremely probable that the Jews were not only permitted, but encouraged, or perhaps commanded, to coin money, which they had never yet done, as they still made use of a metallic medium of exchange, in the inconvenient form of a currency passing by *weight*, and not by *tale;* the pieces of silver, in every money transaction of any importance, being *weighed,* just as they were in the time of Abraham, when that patriarch "*weighed* to Ephron four hundred shekels of silver, current money with the merchant," as the price of the field of Machpelah. The shekel weight of silver had no doubt, originally, a reference to simple barter; and represented very probably the weight of silver which was exchangeable for a lamb, as the denomination for money, used in Job, is not *shekel* but *kesitah* (a lamb). This weight long remained among the Jews that upon which larger amounts were calculated, and therefore became the standard unit which was determined upon when a positive coinage was issued. If the first issue took place, as now supposed, at the time of the conquests of Alexander, there would be an additional reason for adopting the weight of the ancient shekel as that

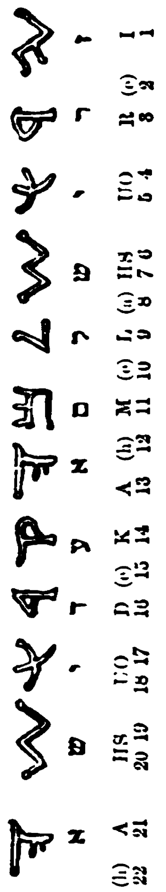
* Some have doubted this statement of Josephus, in consequence of the event not being mentioned by Arrian. But it may have been omitted by Arrian as not essential to the general history; while to Josephus, as a Jew, it had an especial interest.

of the chief unit of the public money, as it corresponded very closely with the Macedonian didrachm, which formed the bulk of the silver money of Philip II., still circulating abundantly in the reign of his son. The early issues of Judæan money were exclusively silver, the Jewish terms for *money* and *silver* being, in fact, synonymous, as with the modern French, who, like the ancient Jews, have no other term for money than *argent;* even gold or copper money being equally *de l'argent.* Shakespeare did not, therefore, prove himself a learned numismatist when he spoke of "shekels of the tested gold;" as no gold shekels, as coins, ever existed. Supposing the first issue of Jewish coins to have taken place during the supremacy of the high priest, Yaddous, it is natural to suppose that the types adopted would be of a strictly religious character, forming a kind of public declaration of the national faith, which had just re-asserted itself under the protection of Alexander, after having been discountenanced as much as possible both by the Assyrian and Persian rulers of Judæa.

Among the coins formerly attributed to Judas Maccabæus are a certain class, the size and thickness of which, combined with the bold, broad, and simple execution of the devices, mark them out as belonging to a different epoch to the others. The greater thickness, and slight convexity in the middle, combined with the style of art of the types, at once suggest a general similarity of workmanship to that of the Greek coins of the Alexandrian period, especially those of the neighbouring Greek cities of Ephesus and Damascus. It is these pieces, therefore, that have now been assigned to a coinage supposed to have taken place under the auspices of the high priest, Yaddous, at the instigation of Alexander the Great. Coins thus issued would naturally be expected to bear some allusion to the unexpected liberation from the Persian thraldom which had recently taken place; and we find, in fact, on the coins which have now been assigned to this epoch, the inscriptions, "first year," "second year," "third year," and "fourth year of the liberation of Israel." There is thus every reason to consider the attribution correct; although it gives to the Jews the credit of a monetary issue similar to that of neighbouring nations nearly two centuries earlier than was previously supposed.

The engraving (Fig. 1) is taken from one of these coins, a silver shekel, bearing the numerals of the second year. The obverse has for device a branch bearing three flowers, in allusion to the twelve rods or sceptres which were ordered for the twelve tribes, and placed in the arch of the temple, the rod bearing the name of Aaron being found in the morning covered with leaves and almond flowers. The style of the letters of the inscription are additional proof of the

correctness of the present attribution of these coins to the epoch of Alexander, as they closely resemble in style the treatment of the letters of Greek coins of the period, particularly in the little knob or pellet by which all their main lines are terminated. The inscription is in the ancient Jewish character, commonly known as the Samaritan, which was used for all national and monumental purposes long after the common Hebrew letters, acquired during the captivity, had been in general use for ordinary purposes. The inscription reads, beginning at bottom of the right-hand side, and reading upwards, *Jeroushalem ha kedoushah*, Jerusalem the Holy. The vowels, omitted after the manner of all early oriental systems of writing, are not supplied by *points*, as in the later Hebrew, which renders some of the inscriptions very difficult to read; but those of the coin under description may be easily followed, on reading it from right to left in the usual Hebrew manner, as in engraving, and comparing it with the common Hebrew and English letters, between which the omissions of aspirates and vowels are supplied within brackets; the whole of the English letters, double letters, and vowels being numbered, to mark unmistakeably the order of succession in which they are to be read.



On the reverse, the type consists of a vase, said by some numismatists to represent the sacred cup called *Omer*, filled with manna, in allusion to the following passage in Exodus xvi. 32: "And Moses said, This is the thing which the Lord commandeth, Fill an omer of it to be kept for your generations, that they may see the bread with which I fed them in the wilderness." Above the cup are the two letters *Schin* and *Beth*, expressing "second year," the first being the initial of *Shinath* (year), and the second being *Beth*, the second letter of the Jewish alphabet, used as the numeral 2 by the Jews, who, like the Greeks, adopted the letters of their national alphabet, in their regular order, for their numerals. The inscription of the reverse, which may be read by the aid of the explanation above, is S h (e) k (e) l I sh r a (e) l, Shekel of Israel.

The high priest, Yaddous, lived ten years after the granting of the privileges referred to, dying about the same time as

Alexander, in 323 B.C. But no money appears to have been issued after the fourth year of the new *regime.* This circumstance is by some considered to invalidate the attribution of these coins to the epoch of Yaddous; yet when it is considered that an immense drain upon the resources of all the tributary provinces took place during the last six or seven years of the life of Alexander, to meet the vast expenses of the campaigns in the far east, it is not astonishing that the Jewish treasury became exhausted after the fourth year, and that no more coin was issued. This view seems borne out by the fact that the coins of the fourth year, though stamped as shekels and half-shekels, are only copper—the substitution of the baser metal betokening a period when the country had already been drained of its silver.

We next come to the coinages which may fairly be attributed to the Maccabæan dynasty. After the death of Alexander Judæa fell under the dominion of one or other of the dynasties established by the generals of Alexander, who erected for themselves independent kingdoms out of the vast Macedonian empire which he had founded. At one time Judæa was possessed by the Greek kings of Egypt, Ptolemy Lagus, and his descendants; while at another it fell beneath the sway of the Seleucidæ, the descendants of Seleucus Nicanor, who first established the Grecianised kingdom of Syria; and this state of things deprived the Jews of almost every vestige of national life. Greek manners and the Greek language prevailed, and the Judaic identity seemed likely to be crushed out; but it was not so destined. The last attempt of the Greek sovereigns of Syria to thrust the religion and language of Greece upon the subjugated Jews, produced a re-action and revolt, which resulted in the temporary re-establishment of Jewish independence. The statue of the Greek Zeus, or Jupiter, had been placed in the temple by Antiochus IV., and the high priesthood had been sold to renegade Judæans; first to a certain Joshua, who assumed on the occasion the Greek name of Jason, and then to Onias, who changed his name to Menelaus, and, to raise the necessary money for purchasing his appointment, sold the sacred vessels of the temple. The Samarians had, in the meantime, accepted the Greek faith without scruple, and set up a statue of the Hellenic Jupiter in their temple. Antiochus IV. next proceeded to publish an edict directing uniformity of religious worship throughout his dominions, and a revolt in Judæa immediately followed this last and most oppressive edict, which threatened the Jewish faith with utter extinction. At Modin, a small town near Lydda, Mattathias, a Jew, a man of priestly race, refused, in 170 B.C., to obey the injunction of the king's agents appointed for the establishment of the religious

faith of the Greeks, slew the principal officer with his own hand, and retired to the mountains with his five sons, John, Simon, Judas, Eleazar, and Jonathan. Being there joined by great numbers of insurgents, a permanent and serious resistance was offered, and the national independence was partially re-established, after a series of signal successes against the Syrian troops. He was the great-grandson of Asmonæus (or, in the Hebrew form, Chasmon); and, in consequence of this descent, his successors became known as the Asmonæan dynasty.

Mattathias died about 170 B.C., in the first year of the revolt; and though no coins can at present be attributed to him, it is probable that some were issued, and may yet be brought to light, as he would, doubtless, have been anxious to put forth such an evidence of the independent sovereignty which he had established. Coins bearing the name of Mattathias, and which were formerly assigned to him, have now been proved to belong to his descendant, Antigonus, as will be shown further on.

He was succeeded by his son Judas, who, after two decisive victories, entered Jerusalem in triumph, during a Syrian civil war which broke out on the death of Antiochus. He eventually fell in a battle, overwhelmed by numbers, in 161 B.C. Coins quite recently discovered are now attributed by M. de Saulcy to Judas Maccabæus,—they are small copper, and only two specimens are as yet known. These coins are of poor workmanship, and exhibit that degradation of art which was sure to follow such political convulsions as were at the time leading to the rapid dissolution of the great Syrian empire of the Seleucidæ, and the disturbances caused, at the same time, by the struggles of the Jews to establish their independence. The device of the reverse consists of two horns of abundance; and this type thenceforth became a sort of family badge or device of the Asmonæan dynasty. The engraving (Fig. 2) is from the coin recently discovered near Jerusalem, which has, with every show of probability, been attributed by M. de Saulcy to Judas Maccabæus. The inscription should read, *Jehoida Cohen*—"Judas, the high priest"—followed by the titles "illustrious" and "friend of the people."

It has been suggested that the cognomen of Maccabæus is derived from the Hebrew *Maccab*, a hammer, in allusion to the heavy blows inflicted on the Syrian army in the course of his rapid and decisive victories; just as in our own annals Edward I. was termed *Malleus Scotorum*, "the hammer of the Scots," a title inscribed on his tomb in Westminster Abbey. Other archæologists have, however, asserted that the name was assumed in consequence of the Hebrew letters, M. K. B. E. borne on the standard of Judas, which were, in the Hebrew,

the initials of the passage in Exodus (xv. 11)—"Who is like unto thee, O Lord, among the gods?"

Jonathan nominally succeeded his brother Judas in 167 B.C.; but as the Syrian forces after the death of Judas obtained possession of nearly the whole of Judæa, he was compelled, with his brother Simon, to act entirely on the defensive; and, about this time, the other remaining brother, John, fell in battle. The increasing confusion caused by various pretenders to the Syrian monarchy were, however, favourable to Jonathan, and he not only regained the independent position formerly held by Judas, but was influential in bringing the affairs of Syria to a temporary settlement; he was treacherously assassinated in the year 144 B.C. There are small copper coins now attributed to Jonathan very similar to those of his brother Judas; the coins of both being very late additions to the series, though Barthelemy had already deciphered the name of Jonathan in 1749. The inscription is of similar import to that on the coins of Judas. The representation (No. 3, in the plate) is from the engraving published by M. de Saulcy. The inscription reads Jehounathan, with the title of "high priest," and also that of "supreme," and "friend of the Jews." The engraving is larger than the real coin, in order to show the inscription more distinctly.

Simon succeeded his brother Jonathan in 144 B.C. He was on the whole the most steadily fortunate of the five sons of Mattathias, and eventually drove the Syrian garrison from the citadel of Jerusalem, thus establishing the entire independence of the capital, and also of the greater part of Judæa. It was to Simon that Antiochus, the son of Demetrius, formally conceded the right to coin national money, as related in the Chronicles of the Maccabees, thus acknowledging the independence of Judæa as a distinct state. When, therefore, modern numismatists first succeeded in reading the inscriptions on the Jewish money, and coins were actually found with such legends as "Liberation of Zion," "The Liberation of Jerusalem," and, above all, "Simon, prince of Israel," with dates such as "the first," "the second," "the third," "the fourth year of independence," it was natural that they should be attributed to Simon, the brother of Judas Maccabæus. The Jewish coinage has, however, as previously stated, been recently distributed in such a way that not a single well-authenticated coin is now attributed to the last and greatest of the sons of Mattathias. It is, however, most probable that he did issue coins, and that specimens of them will yet be discovered. Simon was treacherously assassinated by his son-in-law, Ptolemy, governor of Jericho, in the year 135 B.C.

John Hyrcanus, the son of Simon, succeeded his father,

and though he did not assume the title of king, he reigned as an independent monarch for twenty-nine years. The coins he issued bear the dynastic type of the two horns of plenty established by his uncles, Judas and Jonathan. The name within the wreath on the obverse is spelt Jehouhanna, followed by the usual titles; and the Greek A above the Hebrew inscription has been explained as the initial of Antiochus Sidetes, with whom and John Hyrcanus an alliance existed in 134 or 135 B.C. No coins but those of small copper are known of this prince. He died 106 B.C. The coin engraved at No. 4 has been attributed to John Hyrcanus, though the inscription does not agree with those engraved by M. de Saulcy.

Aristobulus (Judas Aristobulus) succeeded his father, and was the first of the Asmonæan dynasty who assumed the name of king. He only reigned one year, dying of an illness aggravated by remorse for having put to death his mother, who had been left regent of the kingdom by Hyrcanus. Small copper coins, similar to those engraved at Figs. 2 and 4, have been attributed to Aristobulus. Others, with Greek letters, forming part of his Hebrew name, written as ΙΟΥΔΑ, etc., are now attributed to him, and are the coins previously alluded to which were formerly assigned to the first Judas Maccabæus.

Alexander Jannæus (Jannæus being a corruption; his native name Jonathan), another of the sons of John Hyrcanus, succeeded his brother Aristobulus, and reigned from the year 106 to 105 B.C. It will have been seen that the custom of adding a Greek name to the national one had then become a fixed custom, and that throughout Judæa the Greek element of civilization, at that period, was so strong that the foreign name, and even foreign types, were placed on the national coin; for the coins of Alexander Jannæus do not bear, in the specimens yet known, the usual Asmonæan type, but in its stead the well-known Syrian emblem of the Seleucidæ, the anchor, implying perhaps a close alliance with one or other of the princes of the Syrian family. Alexander Jannæus died in 78 B.C., after a tempestuous reign, bequeathing his kingdom to his widow.

Alexandra reigned from 78 to 69 B.C. Her coins have legible Greek inscriptions round the anchor type; but the Hebrew legends have not been deciphered.

Hyrcanus II. This feeble prince succeeded his mother Alexandra, but was displaced by his brother, Aristobulus II., which led to that appeal to the Roman power, already predominant in Syria, which ended in the taking of Jerusalem by Pompey. The Roman commander reinstated Hyrcanus, carrying off Aristobulus prisoner to Rome. Further troubles led

to the plunder of the temple and its sacred treasures by Crassus, then holding the chief command in Syria. Hyrcanus, who had been left in the government of Judea by Pompey and Crassus, but only with the title of high priest, received back his title of king from Julius Cæsar, in return for services rendered during the Egyptian war. Hyrcanus had betrothed his daughter Mariamne to Herod, the son of Antipater, who had been appointed governor of the newly-subdued province of Idumæa. The influence of Herod rapidly increased after this alliance. His military talents, and general capacity for government, were of a high order, and he eventually usurped the throne, Hyrcanus being put to death. There are doubtful coins both of Aristobulus II. and Hyrcanus II., those of the latter bearing the original Asmonæan inscriptions and types.

Antigonus, a son of Aristobulus II., succeeded with the aid of a Parthian army in driving the usurper Herod out of Judæa. Flying to Rome, however, Herod obtained, through the influence of Antony, a recognition of his assumed title of King of Judæa. Antigonus endeavoured to defend himself; but Herod, supported by Sosius, a lieutenant of Marc Antony, took Jerusalem after an obstinate siege, and Antigonus, the last of the Maccabees, who surrendered himself to the Roman general, Sosius, was sent to Antony, then at Antioch, who ordered the unfortunate prince to be executed as a common malefactor, in the year 37 B.C. Most of the coins issued by Antigonus have for principal type a single horn of plenty, with the legend *Kohen Gadol* (illustrious and high priest?) in old Hebrew character; and on the other side (in Greek characters) the name of Antigonus, abbreviated, with the title of king, as shown at Fig. 5. Antigonus also bore the national name Mattathias, in honour of the founder of the dynasty; but the Roman and Greek interests combined had thrown the Jewish characteristics into the shade, and the once honoured name of Mattathias does not appear on the national coin as the native name of the last of this line of native princes.

Herod, surnamed the Great, lifted to the chief power in Judæa by the influence of Marc Antony, issued coins which have still more or less of the character of those of the Asmonæan race. Some of these, all small copper, have even the type of the two cornucopiæ. Others, issued before he was allowed by the Roman authorities to assume the title of king, bear that of tetrarch. Many foolish fables once existed respecting some of the types of the coins of Herod; among others that the star, a Syrian emblem used by some of the Asmonæan princes, was the "star of Bethlehem," though certainly the last emblem in the world likely to be adopted by the first enemy of Christianity. The most common types of the coins of Herod are the helmet,

the Syrian anchor, the bunch of grapes, etc. The death of Herod, which, actually, occurred in the same year as the birth of Christ, would appear to have happened four years before, according to the commonly accepted Christian era; and it is assumed that he may have been urged to the slaughter of the children of Bethlehem, recorded by St. Matthew (but not mentioned by Josephus, or any other contemporary historian) by the last pangs of the painful and irritating disease of which he died. This has been assumed, because such an act of gratuitous cruelty appears inconsistent and consequently improbable; but when it is considered how many of his own children he put to death, in consequence of idle suspicions and jealousies, he seems to have been fully capable of such an act, if he had deemed it politically advisable—an estimate of his character widely prevalent in his own day, as we learn from the well-known exclamation of Augustus, when he heard of the political murders of Herod's two sons, Alexander and Aristobulus, who had been brought up at the Court of Rome—"Better to be the hog of Herod than his son," said the emperor—*Melius est Herodis esse porcum quam filium.*

By the Will of Herod vast sums in money, and gold vases and jewels of great value, were bequeathed to Augustus, and his territories were divided between his sons, Archelaus and Antipas. Each claiming the whole dominions of their father, both proceeded to Italy to lay their claims before the Roman Emperor, who confirmed in all its main features the will of Herod, giving the tetrarchies of Galilee and Peræa to Antipas, while Archelau sbecame ethnarch of Judæa, with a promise of the eventual title of king. After a reign of ten years, however, Antigonus was convicted of cruelty and deposed by Augustus, A.D. 7, and died in exile at Vienne, in Gaul. He issued small coins similar in general character to those of his father. The most usual have the prow of a vessel, the Syrian anchor, or a helmet, and a Greek inscription round the type. The name is generally abbreviated, as ΗΡΩ, and the title of ethnarch as EΘN. After his expulsion Judæa was made a Roman province, and Annius Rufus appointed imperial governor.

The Roman procurator, Copponius, had already issued a provincial coinage for the use of Judæa, bearing date the year 31, after the Battle of Actium, and coins of the same class were most probably struck by Annius Rufus, as ascertained by the date, Λ. ΓΘ (for Λυκαβας Γο). The Romans, in their eastern provinces, dated their public records, and the coinage, from the Battle of Actium, which first placed Egypt and the regions of Asia bordering on the Mediterranean directly under the imperial government. That event took place in the year 31 B.C.;

so that the date on the coin issued by Annius Rufus, and bearing the Actian date, "year 39," corresponds to the year 8 A.D. The type of the obverse of this coin (Fig. 6) is a palm tree, with the inscription ΚΑΙΣΑΡΟΣ (of Cæsar), implying money of Cæsar. The palm tree, which we find here acknowledged by the Roman authorities as the national symbol of Judæa, we shall afterwards find used as a principal type on the coins issued by the revolted Jews in the reign of Nero, and again on those issued during the great revolt in the time of Hadrian.

The first procurators of Judæa were not allowed a very lengthened enjoyment of office, and in the year 26 or 27 A.D., Gratus, the fifth procurator, was superseded by Pontius Pilatus, who was appointed by Tiberius, in the year 27 A.D., and held the office for ten years. The provincial coins issued by these successive procurators may be assigned to each by the aid of the Actian date, and specimens bearing Actian dates between the years 58 and 68 of that era may be considered to have been issued under the auspices of Pontius Pilate. Pilatus, as is well known, was deposed for peculation and other abuses of power, in the last year of the reign of Tiberius, 37 A.D., and died in exile.

Herod Antipas had continued tetrarch of Galilee and Peræa, after his father's expulsion from Judæa, and it was in consequence of his being accidentally in Jerusalem, then entirely under Roman rule, that Christ was sent before him as belonging to his jurisdiction, on account of his supposed Galilean origin. It was also Herod Antipas who ordered the execution of John the Baptist, because he had blamed his unlawful marriage with Herodias. After the accession of Caligula, in 37 or 38 A.D., Antipas went to Rome to solicit the empty title of king, which had just been conferred on his nephew, Herod Agrippa. But Agrippa, who had been brought up in Rome, was a great favourite with the Emperor, whose youthful companion he had been, and who, therefore, unjustly conferred upon him the dominions of his uncle Antipas, in addition to the tetrarchies which had already been conceded to him, while Antipas was banished to Spain, and died in exile. Small copper coins are attributed to Antipas, most of which bear the title of tetrarch.

Herod Agrippa (in the year 37 A.D.) received from Caligula the tetrarchies of Philippus and Lysanias, with the title of king; and afterwards the tetrarchies of Galilee and Peræa. On the death of Caligula, Agrippa, being in Rome at the time, greatly aided in placing Claudius upon the imperial throne, and obtained in return the provinces of Judæa and Samaria as additions to his kingdom, which thus became more extensive than that of Herod the Great, while at his request the little district of Chalcis was conferred upon his brother Herod, also with the

title of king. Agrippa immediately commenced fortifying Jerusalem in a manner which would have rendered it impregnable, but the works were arrested in consequence of the aroused suspicions of Claudius. His government was generally characterised by mildness; he had interceded with Caligula on behalf of the Jews, when they opposed the determination of that emperor to set up his own statue in the temple; and yet, to court popularity in Jerusalem, he consented to the death of the apostle James, the brother of John, and cast Peter into prison. He died at Cæsarea, the seat of government of the former procurator, as related in Acts xii., at the age of fifty-four, in the year 44 A.D. There are coins of this prince which have for type a kind of portable canopy or sun-shade, an oriental emblem of power, or, as described by some, a tabernacular emblem. The inscription is ΒΑΣΙΛΕΩΕ ΑΓΡΙΠΠΑ, "of the King Agrippa." These coins are, however, of uncertain attribution, and are by some assigned to his son, Agrippa II.

Herod Agrippa II. On the death of Herod Agrippa, his son Agrippa, who was being educated at the court of Claudius, in Rome, was only seventeen years of age, and a Roman procurator was therefore appointed to the government of Judea and the annexed provinces. The care of the temple of Jerusalem, and the power of appointing the high priest, were, however, confided to a native prince, the brother of the late king, who was still sovereign of the petty state of Chalcis. In A.D. 48, after the death of Herod of Chalcis, the principality of Chalcis was conferred on Herod Agrippa II., with the same privileges in regard to the superintendence of the temple and the appointment of the high priest. Several additions were afterwards made to the districts placed under his jurisdiction. It was before this Agrippa that St. Paul defended himself against the charges of the Jews. Agrippa being at Cæsarea, the seat of government of the Roman procurator, he was appealed to by Festus, as a native prince well acquainted with Jewish history and customs, and to this circumstance Paul refers when he expresses his satisfaction at pleading his case before him, especially, as he says, "Because I know thee to be expert in all customs and questions which are among the Jews." The Jews became at this time impatient of their dependent condition, on account of the heavy taxes extorted by the Roman governors, and Agrippa in vain attempted to dissuade them from rebelling against the power of Rome. On the breaking out of the insurrection, he sided with the Romans, and after the fall of Jerusalem retired to Rome, where he received the rank of prætor, and died there in the seventieth year of his age, in 98 A.D. It is difficult to

distinguish the coins issued under his authority from those of his predecessor of the same name. He was the last prince of the Herodian line.

This insurrection of the Jews, which broke out towards the close of the reign of Nero, notwithstanding the efforts of the last of the Herodian princes to prevent it, was principally provoked by the tyranny of Florus Gessius, who had succeeded Albinus as procurator of Judæa. The Jewish coins illustrative of this epoch are quite a recent numismatic discovery, for which archæologists are indebted to the perseverance and skill of M. de Vogüe. They have for types a branch of palm, and various other national types, but always avoiding those of the Asmonæan, or Herodian race of kings. The petty tyranny of the last native kings, though restricted both as to territory and regal privileges, had been in fact so distasteful to the Jews, that they had even petitioned, under Herod Archelaus, the son of Herod the Great, that Judæa might be annexed to the Roman province of Syria. It may be easily imagined, therefore, that the monetary types of the Asmonæan and Herodian dynasties had become distasteful, and that the more ancient native types, similar to those used on the first Jewish coinage, issued by the high priest Yaddous, should be preferred. The Jewish coins struck during the revolt against Florus bear the name of Eleazar, who had been elected high priest by the insurgents, and had assumed the sovereign privilege of coinage. There are a whole series of coins, of both silver and copper, bearing this name, with inscriptions in which the ancient character was again adopted. The obverse of the coin (Fig. 7) is one of this series, and has for type a one-handled vase with an inscription, which, in modern Hebrew, should read אלעזר הכוהן, "Eleazar the priest." The reverse has a bunch of grapes; but many other types of a similar class occur in other specimens, bearing this name, all of which are superior in workmanship to those of the first Maccabees.

Gallus, the governor of Syria, having gone to the assistance of Florus at the beginning of the rebellion, and having sustained a disastrous defeat, Vespasian, then merely a popular general, but known for his skill and determination, was sent out to quell the revolt. During his prosecution of the war, which became a very serious one, the death of Nero took place, and, after brief possession of power, that of his successors, Otho and Vitellius, also. Vespasian being elected emperor while still directing the operations of the Roman army in Judæa, transferred the command to his son Titus, who eventually reduced the city on the 8th of September, A.D. 70, after one of the most obstinate and desperate defences on record.

After the taking of Jerusalem, Titus issued a provincial

coinage of copper for the use of Judæa, somewhat larger and different in character to that of the procurators. These coins bear the name and titles of the issuer abbreviated, as ΑVΤΟΚΡ ΤΙΤΟΣ ΚΑΙΣΑΡ; and also the inscription, ΙΟΤΔΙΑΣ ΕΑΛωΚΙΑΣ, in allusion to the complete subjection of the Jewish people. But the most remarkable coins issued on this occasion were those struck in Rome by order of the Roman senate, which are among the most interesting of the whole Roman series. The reverse (Fig. 8) represents Titus in a posture of triumph, placing his foot upon a clod of earth, symbolizing the subdued territory, while a personification of Jerusalem, as a female figure, wearing a turretted crown, weeps, in a dejected posture, beneath a palm, the national type of Judæa. This device is accompanied by the inscription, "Judæa Capta," which at once removes all doubt concerning the true meaning of this interesting allegorical composition.

After the year 70 A.D., all signs of an independent kingdom were obliterated. The last of the native princes, Herod Agrippa, though he had sided with the Romans after the breaking out of the revolt, was compelled to retire into private life; and great obscurity prevails over the events which took place in Judæa, as a Roman province, from the year 70 A.D. to the year 117. In that year, at the time of the death of Trajan, Hadrian was at Antioch; the affairs of the East being then in a disturbed state, which all the energy and military talents of his predecessor had not been able to quiet; among other difficulties, Syria and Judæa were in a state of quasi insurrection, though it was not till the year 131, and after an intervening period of comparative repose, that the last serious revolt took place. Most of the ancient Jewish privileges had been abolished, one after another, as it was thought by the Roman authorities that the observance of ancient customs, and especially of religious festivals of peculiar character, tended to keep up and nourish feelings of nationality and independence. Among the customs forbidden was the rite of circumcision; but it is stated by some authors, and among others by St. Jerome, that a determination on the part of the emperor to make the city of Jerusalem a military fortress, and the seat of a Roman colony, under a new Roman name, more greatly than any other grievance, tended to stir up a serious revolt. That a revolt took place at this time is well known, and there are certain coins, bearing national Jewish types and Hebrew inscriptions, which M. de Saulcy attributes to the first years of this rebellion, before the election of Simon Barcocebas (one of the leaders of the revolt) to the chief power, as high priest and prince of Israel. The coins so attributed by M. de Saulcy are similar in type to those afterwards issued by Barcocebas during the

temporary independence secured by the revolt, but they have only for inscription, "The liberty of Jerusalem," and "Year 1 of the deliverance of Israel," and no name. Barcocebas, or more correctly, *Bar-kaou-kab* (the son of star), becoming the sole director of the revolt, it assumed under his command important dimensions, and he rapidly made himself master of 50 fortresses and 985 villages, which called serious attention to a revolution which had not at first created much alarm. Barcocebas, after these successes, assumed the title of king, and also of Messiah, continually styling himself "prince of Israel," on that fine series of coins issued by his authority, which were formerly attributed by numismatists to the glorious reign of Simon Maccabæus. Their present assignment to Simon Barcocebas appears fully justified by their general character and appearance, which differs entirely from that of the Jewish coins of the Maccabæan period. Their workmanship bears a close resemblance to that of the Romano-Egyptian coins of the period of Hadrian, both in a peculiar solidity of make, and also in a liny rigidity of outline exhibited in the devices. The types are of analogous character to those of the ancient shekels of Yaddous, and the inscriptions bear a similar import, proving that the very first emission of national money, under the protectorate of Alexander the Great, still possessed more pleasing associations than the subsequent issues of the native princes.

The larger silver coins of the issues of Barcocebas appear to be tetradrachms or double shekels. Their weight, however, corresponds more accurately to that of Roman denarii, the large pieces being of the weight of four. The one engraved (Fig. 9) is of the well-known "Temple" type, in which the oriental character of the capitals and bases of the columns are very peculiar, resembling those of the Persian architecture of the Alexandrian period, which may be an allusion to the original temple, and not to the building then existing, which, as Josephus informs us, had been partly rebuilt by Herod, who, in his restorations, employed the Corinthian order. The inscription, part of it being on each side of the columns, appears to read "Simeon," Barcocebas having doubtless assumed the still popular name of the celebrated Simon Maccabæus. The type of the reverse is an ornamental bunch or bouquet of flowers and branches, called *loulab,* such as was carried by the priests in the Feast of the Tabernacle, and by the side of it is a cone of cedar, the inscription being, "Lecheruth Jeroushalim," ("to the liberty of Jerusalem,") with numerals expressing the year 2 of the liberation, after the manner of the coins of Yaddous. Among a number of other types, all having reference to the national and religious institutions, those of the copper coins engraved are as interesting as any.

On the obverse of some of them (see Fig. 10) is the national emblem of the palm, as it appeared on the famous Roman sestertius of Titus. This type is accompanied by the name "Simeon," which has sometimes the addition "Nassi Israel," prince of Israel. On the reverse of this type is a vine leaf, the inscriptions accompanying which are various. The same types also occur on silver coins.

The best of these coins are of very superior workmanship in their peculiar style, and their size and general character make them a fitting climax to the numismatic history of Judæa. Barcocebas was not joined by the Christians of Jerusalem in consequence of the great cruelties which he perpetrated, by which he lost a very important element of possible success. Nevertheless, the rebellion was not subdued till the popular commander, Julius Severus, had been called from Britain to lead a new army against the Jewish insurgents. As the rebellion drew to a close, coins of a very inferior character were issued, some of them being, in fact, Roman denarii, over the devices of which the Jewish symbols and inscriptions were stamped, in many cases the original workmanship of the Roman coin being still discernible. The types of a large copper coin of unusual size, bearing the inscription, "Simon, prince of Israel," and year 1 of the redemption of Israel, appears to have been struck over an old Roman sestertius of the early period of the empire, before the size of the Roman large copper was reduced.

These last-named coins, which finally close the Jewish series, were at one time the only coins attributed to the epoch of the revolt of Simon Barcocebas.

The insurrection being finally and completely subdued, a Pagan temple was erected in a conspicuous situation, and statues of Jupiter and Venus stood on the spot where the crucifixion of Christ had taken place, while Jews were forbidden from any longer inhabiting Jerusalem, which was at once converted into a Roman colony under the title of Colonia Ælia Capitolina, in honour of Hadrian's prenomen, Ælius. Roman coins of this colony, of precisely the same class as those of other Roman colonies, were struck on the occasion, and similar coins were issued during the reigns of succeeding emperors. A tolerably complete series exists up to the reign of Trajanus Decius, and, with some omissions, even to the time of Hostilianus, during which long period the name of Jerusalem was as it were obliterated, and that of Ælia Capitolina adopted in its place.

Before closing these remarks on the ancient coinage of the Jews, it may not be amiss to put travellers in the East on their guard against purchasing at extraordinary prices the coins that will be offered to them while at Jerusalem, as being found in

recent excavations. Most of these are only casts or electrotypes from the real coins, having a certain interest as true copies, but not to be paid for as originals. It may also be interesting to exhibit an engraved specimen of the clumsy forgeries of Jewish coins which deceived the numismatic amateurs of the last generation, and for which purchasers are still found among the unwary. The specimen engraved (Fig. 11) belongs to the Messrs. Groombridge, who have kindly lent it for this occasion.

The examination of the obverse alone will be sufficient to exhibit the wretchedness of such attempts at falsification. The type is a vase of quite modern fashion, the handles and other parts being ornamented in the most paltry style of the last century, instead of having the severely simple character of the *Omer* of the ancient shekels (engraving No. 1), which it is intended to imitate. The smoke or incense issuing from it, a most unmeaning addition, is also treated in a flat, unartistic, and modern feeling. But the great and fatal mistake of the forger is the inscription, "Shekel Ishrael," in which the modern Hebrew letters are used instead of those of the ancient alphabet, which was always employed for monumental and other public purposes in Judæa, especially for the coinage, even after the later kind of writing had been long generally prevalent as the popular style. Some of these forgeries have been made to bear the name of Solomon, David, or even Samuel, though it is well known that no Jewish coin of any kind was issued previous to the epoch of Alexander the Great, several centuries after the time of Solomon; and that no Jewish coins bearing the *name* of a prince or high priest were issued till the comparatively late period of the Maccabees.

Many other coins, illustrative of Judæan history, might easily have been added to those described above, were it not that the article has already assumed dimensions of far greater extent than was originally intended.

CLUSTERS, NEBULÆ, AND OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

NEBULÆ.

We opened our list with a promise of glorious and wonderful objects of contemplation, and our readers, we believe, will not have found themselves hitherto deceived by overwrought expectations. We cannot ensure them a continuous succession of scenes of equal interest and wonder; our next, however, will be little inferior to its great predecessor; and those accustomed to a search after obscure and difficult objects will readily adopt the epithet of "overpowering," which Smyth has so characteristically applied to it. It is

3. *The Great Nebula in Andromeda.* Being readily visible to the unarmed eye, in consequence of its brightness and extent, it will give but little trouble in the finding. Having first identified β *Andromedæ* from the directions following No. 63 of the Double Star list (INT. OBS., vol. ii., 374), we shall perceive that this star is the lowermost of a short line of stars tending in a *n p* direction: of these the next to β is μ; the third is ν; and a little *p*, or to the right of ν, the nebula will be immediately recognized by its misty aspect. It is so conspicuous that, like the nebula in Orion, it is singular that it should have found no place among the "Nebulosæ" of the ancients. It was, however, perceived before the invention of the telescope, being represented in a diagram whose date seems to have been towards the close of the 10th century.* Tycho Brahe, strange to say, makes no mention of it, though he carefully observed the adjacent stars; and no further reference to it occurs till 1612, Dec. 15, when Simon Marius first, as it would appear, viewed it with the telescope, and gave a very good account of it. This, however, seems to have drawn little attention, as the great observer Huygens was ignorant of its existence even in 1659; but in 1664 the passage of a comet through that region was the means of bringing it finally into general notice. For a length of time subsequently it was so differently described by different observers, that Le Gentil,

* Herschel II. and Smyth have given A.D. 905; upon what authority does not appear; but from Bond's statement it would seem to follow that this is a misprint for 995. Bond in turn has misprinted 1662 for 1612, and the Latin title of one of Bouillaud's treatises, as cited by him, contains several strange errata. He is also mistaken in supposing that no intimation of its having been seen is to be found between 1612 and 1664, as Smyth tells us that Bouillaud, in 1667, mentions its having been noticed 150 years previously by an expert though anonymous astronomer.

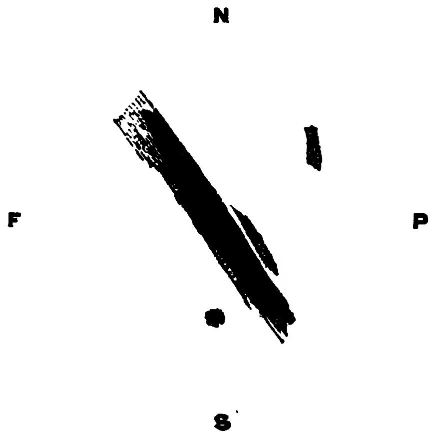
about the middle of the last century, was led to conclude that it must have varied in form and brightness; an inference which, however, seems to have had no foundation, except in the inadequacy of the instruments then in use. It stands No. 31 in the catalogue of Messier, communicated to the Academy of Sciences in 1771. Sir W. Herschel estimated its dimensions at about $1\frac{1}{2}°$ in length by upwards of 16′ in breadth, and considered it undoubtedly the nearest of all the great nebulæ. His illustrious son in 1826 described it as "very bright and of great magnitude, and altogether a most magnificent object," its brilliancy increasing gradually from the edges to the centres where he found a kind of indistinct nucleus of stronger light, about 10″ or 12″ in diameter. Lamont observing it ten year, afterwards at Munich, with a power of 1200 on a very large achromatic, gave this magnitude about 7″. On the mounting of the great achromatic by Merz, of $14\frac{3}{4}$ inches aperture and 23 feet focal length, at the Cambridge Observatory, Harvard College, U.S., in 1847, nothing was remarked at first but a vast number of stars of various magnitudes scattered over its surface, an almost star-like nucleus, and a sudden termination of the light all along the *np* side. But it was subsequently perceived that this abrupt bordering was occasioned by the presence of a long dark streak, $1\frac{1}{2}'$ broad, beyond which the hazy light recommenced, though with less intensity, for about 4′, when it was a second time interrupted by a similar dark band, and again continued till it faded entirely away. Thus one side of the great mass appeared subdivided lengthways by two dark canals, the innermost nearly 1° in length, straight for half that distance, but subsequently bent a little inwards; the other not so extended in length, and inclined to the first at an angle of about 3°. A truly wonderful structure is thus indicated, but, as it would seem, not without a parallel in the heavens, many other instances of arrangements more or less analogous having been pointed out by Sir J. Herschel and the Earl of Rosse; and unless, as the former has suggested, we can conceive the interposition of imperfectly transparent matter nearer to our eyes (which seems very difficult), we must suppose it to be a kind of stratification of the nebulosity presented edgeways to our sight, and giving us but little opportunity of conjecturing what might be the aspect of the luminous mass viewed in a transverse direction. The Earl of Rosse, indeed, seems to incline to the opinion that there may be an extreme fore-shortening of some kind of annular formation, the dark streak being the perspective projection of an interior void; but he has not referred to the complication introduced by the presence of the second streak, which would seem to require a kind of figure-of-eight arrangement; and,

with the modesty characteristic of a true philosopher, he admits that his explanation is not very satisfactory.

As might be expected, these canals are very difficult telescopic objects, and perfectly hopeless with small apertures. I should never have thought of looking for them but for Secchi's valuable piece of information, that the first or innermost canal is the apparent exterior boundary of the nebula in small instruments, as well as his statement that the 6⅓ inches of the Cauchoix achromatic at Rome were sufficient to show the first, with as much of the nebula beyond it as reaches to the second canal. Thus instructed, I attacked the object, a good while ago, with my 5½ inches, but so entirely without success that I never repeated the attempt till the memorable night of the earthquake, when, the atmosphere being clear, notwithstanding rather *flaring* definition, I detected, with a comet eye-piece, power about 29, as well as with a higher power of 64, the lighter tract between the two canals, like a riband of the thinnest gauze drawn over the dark sky, parallel for some distance to the edge of the main body of light, but separated from it by the innermost of these open spaces. Faint as the object was, even as a mere suspicion, and utterly undiscoverable except from previous knowledge, to my great pleasure it was unquestionably there. I then perceived at once the inaccuracy of the expression that Bond had discovered these canals *in* the nebula, unless it were at the same time stated that he had given to it a previously unsuspected extent,—what he calls the *axis* of the nebula being nearly the whole of it as visible in inferior instruments,—and that these features were to be sought outside of the nebula as commonly seen, in the newly detected part. I became aware at the same time but too plainly with how much justice Secchi has criticised Bond's figure, as giving too much strength to the light between and outside of the canals; a remark made also by the Earl of Rosse's assistant with the 3-feet reflector; in fact the engraving does not correspond with the attendant description, that "the light between them is two-thirds as bright as it is on the inner side of that which is nearest to the nucleus," since it has been made to appear sensibly equal. In my telescope the difference is extreme; the aperture being only just sufficient to make the feeble ray perceptible, at least to vision such as mine.

In other respects, too, Bond's figure is unsatisfactory, the proportional light of the two companion nebulæ being far from accurately given; its defects, however, have been greatly exaggerated in some of the copies, and that given by Arago, if it is to be considered as a copy at all, bears so little resemblance either to the original or to nature that, without a name, it

would be difficult to identify it. The accompanying diagram has no pretension to be considered as a picture, having been sketched subsequently from memory; it is merely intended as a guide to those whose telescopes have light sufficient to warrant an attempt upon the canals. The great nebula lies, as will be at once seen, between two other hazy objects, making the general effect still more remarkable. The one, small, round, and bright (*extremely bright; pretty large; 30″ or 40″ in diameter*; with Sir J. Herschel's 18-inch speculum), was discovered in November, 1749, by Le Gentil, and is known as M(essier) 32, or H(erschel, jun.) 51 (*h* 51, in the unassuming notation of that eminent observer). It lies nearly *s* of the nucleus, at a distance of 26′. The Earl of Rosse expresses little doubt of its resolvability, as to which Bond offers no opinion. The other, 18 H V, *alias* H 44, was discovered by Miss Carolina Herschel, August 27, 1783; it is about 40′ distant from the nucleus in a *n p* direction, but may be brought, with a low power, into the same field with the great nebula, to which its faintness offers an interesting contrast. I have thus seen it well with $3\frac{7}{10}$ inches of aperture. Smyth says that it lies between two sets of stars of four each, each resembling the figure 7, the *p* group being the smaller. Herschel I. gave its dimensions 30′ × 12′; his son, who calls it *pretty bright*, about half that size (but in moonlight). Bond states that it appears, under high powers, to be a coarse cluster of stars. The nature of the great nebula, however, is less certain than that of its companions, and notwithstanding all the pains that have been taken to ascertain it, it has continued sufficiently mysterious. Smyth indeed states that the 3-foot speculum of the Earl of Rosse showed stellar symptoms at its edge; but we have heard of no confirmation of this with the fourfold light of the larger reflector. De Vico and his colleagues *thought* they resolved the nucleus in 1841, with 824 of the Cauchoix achromatic, and Secchi had the same impression in some very clear evenings. But this seems very improbable, when Herschel II. states—in a far inferior climate it is true, but



THE GREAT NEBULA IN ANDROMEDA.

with 18 inches of reflecting aperture—that its nebulosity is of the most perfectly milky irresolvable kind, without the slightest tendency to that separation into flocculi which he perceives in the nebula in Orion, nor is there any sort of appearance of the smallest star in the centre of the nucleus. Secchi himself, afterwards, with the far superior Merz telescope, whose admirable definition gives it, he thinks, more resolving power than even the Rosse reflector, though he perceives five or six points in the nucleus, admits that they are not sharp enough for stars, comparing them rather to the granulations seen in the heart of some comets; and since he finds the surrounding fields for a great distance equally rich in minute stars with those in which the nebula occurs, concludes that the nebula is not resolvable, *si non peut-être dans son centre.* Bond, employing more than twice the light, says, "with high powers, minute stars are discerned on the borders of the nucleus, but it has thus far yielded no evidence of resolution; about 50 stars are visible in the same field with it; no other equal space occurs within the limits of the nebula, containing so few;" and while he estimates that above 1500 stars are visible with the full aperture within those limits, he asserts that they have "the undefinable, but still convincing aspect of not being its components."* It is certainly a singular fact that the two most remarkable nebulæ in the heavens, in point of combined extent and brightness, this, and that in Orion, should be alike characterized by their peculiar difficulty of resolution. Sir J. Herschel has indeed stated that such is the general character of all elliptic as opposed to globular nebulæ; and to this class (though Secchi dissents, giving it a dove-tail or triangular form) our present specimen is usually referred; but we are not brought thus one step nearer to an explanation of the difficulty. If, guided by its brightness and dimensions, we assign to it, with Herschel I., a position of comparative nearness, then its difficulty of resolution, as far as the centre is concerned, might be accounted for upon the supposition of a most extraordinary compactness of aggregation, but this would not explain the "milky" character of its fainter parts, which ought, as in many other nebulæ, to exhibit their components, though the central condensation may remain an impenetrable "blaze." If, on the contrary, we prefer looking upon its intractable character as an argument of exceeding remoteness, we must accept an overpowering result both as to dimensions and splendour. In Bond's telescope its light is diffused through an area $2\frac{1}{2}$° long and nearly $1\frac{1}{4}$° broad, not far short

* Bond's expressions must have been somehow misunderstood by the usually accurate Humboldt, who asserts, in three places, that he actually accomplished the resolution, and considers it one of the most remarkable discoveries of the time. Sir J. Herschel, too, on the same authority, speaks of the "decisive evidence" of its resolvability.

of 5 full moons by 3; so as to involve, whether really or only apparently, the two companion nebulæ; and what conception can we form of a magnitude so vast as would be indicated by this outspreading of a mass of distant suns? or of a brilliancy so vivid as the central portion must possess, to impress itself from such remoteness upon the unaided eye? There is, indeed, no impossibility in either alternative; nothing is too great or too magnificent for Omnipotence; but still the question naturally presents itself, whether this glorious nebula is really composed of stars at all? The doubt is not obtruded upon us, as in the case of that in Orion, by well-grounded suspicions of change; but if the existence of luminous haze were once established in that or any other instance, we should naturally look to it as the easiest explanation of the present difficulty. The final solution must, however, be sought in Orion, not here, where the gradations of light are less sudden, the features less marked, and the stars less brilliant, and hitherto not identified or delineated. But, possibly, results as yet unlooked for may even here be in store for instruments such as the 18½-inch achromatic of Clark, the 20-inch of Buckingham, or the 25-inch on which Cooke is said to be at present engaged.

We shall next proceed to another nebula, in its general aspect very dissimilar to the last: —

4. *The Nebula in the Triangle.*—The little constellation so called, which is pretty well marked out by its stars, lies, in a general sense, between γ *Andromedæ* and α *Arietis*: its *lucida*, α, at the apex of the triangle, being however far advanced towards a line joining the latter star and β *Andromedæ*. Rather more than one-third of the distance along this line, reckoning from the upper end, we shall readily detect our object. It was discovered by Messier in 1764, and is designated as 33 M., or 131 H.; and Herschel II. sees it "enormously large, very gradually brighter in the middle," the diffused nebulosity extending 15′ *s*, and nearly as much *n* from the centre. It has, he observes, "irregularities of light, and even feeble subordinate nuclei and many small stars." His father's V. 17, he thinks probably part of it, and this portion, according to Smyth, was seen mottled by H with his 7-foot reflector in 1783, and afterwards resolved with larger telescopes into stars, "the merest points imaginable." The admiral describes it as large and distinct, but faint, followed by five stars, between which and the object there is an indistinct gleam of mere nebulous matter. The peculiarity of this nebula is its visibility even in very small instruments, combined with especial dimness under what might be supposed more favourable circumstances: thus I could detect it with the finder of my old achromatic, and saw it well with 64 upon its aperture of

$3\frac{7}{16}$ inches, while with 144 it was not distinguishable: with my present finder of $1\frac{1}{12}$ inch aperture it is easily seen as a large faint cloud; it is a beautiful object, much resembling Smyth's description, with 5½ inches and a comet eye-piece, power 29; with 64 the brighter part seems resolvable; but it will not bear 164. The reason of this peculiarity is simply its great extent, which catches the eye as a whole in the large field of a low power, even with a very small aperture, while, filling the whole field of higher powers with feeble nebulous light, it fails in that contrast with the dark sky which is required to make it fairly visible.

We will now turn to another contrast as great as can be well imagined.

5. 34 M. (248 H.) *Persei*. This will be found in the following manner. Reverting to *a Persei* (INTELLECTUAL OBSERVER, vol. ii., 374) we must draw a line *s*, a little *p*, which will soon pass through a conspicuous star, usually little inferior to *a*; this is the well-known *variable*, one of the leaders of that wonderful class, *β Persei*, or *Algol*, which also stands where two lines from *a Persei* and *γ Andromedæ* meet at a right angle. Between *Algol* and *γ Andromedæ*, but nearer to the former, and a little *n* of the line joining them, the eye will catch a dim speck, a small nebula properly so called, which the finder will resolve into stars, and the telescope will spread out into a beautiful brilliant scattered group, requiring a low power to show it well, but then forming a truly magnificent field, including, as Smyth observes, several coarse pairs. H. sees here about twenty stars, from 9 to 11 mag., and as many more of a smaller size. Its discoverer was Messier, in 1764.

OCCULTATIONS.

These will be rather numerous during the present month, including one which may prove well worth attention. Dec. 19th, *π* Piscium, 6 mag., will disappear at 4h. 29m., and reappear at 5h. 13m. 23rd, *l* Tauri, 5½ mag., will be hidden from 4h. 5m. till 4h. 52m. 24th, χ^4 Orionis, 5 mag., from 5h. 38m. for an hour:—unfortunately, near the time of full moon. 26th, 1 Cancri, 6 mag., will disappear at 12h. 38m., and reappear at 13h. 57m. 27th, A^1 Cancri, 6 mag., will be occulted from *11h.* 35m. till 12h. 54m. 28th, *ω* Leonis, 6 mag., from 10h. 59m. till 12h. 13m. This being a very close double star, probably not more than 0″·75 apart (I do not know its present measurement) its occultation would prove of great interest, supposing that the position of the limb is not coincident with that of the stars, as, even with instruments that cannot divide the pair, their duplicity would be made evident by a break in the loss or recovery of light. In this instance, the disappearance unfortu-

nately takes place at the bright limb, and the observer's success will therefore depend upon the very uncertain contingency of his having the point of reappearance at the dark limb just under his eye. This may indeed be secured by a wire in the field with an equatoreal mounting; but it will demand very pertinacious watching, as the actual times, and the consequent amount of duration, will vary from those here given, in proportion to the distance of the station from Greenwich. 30th, 55 Leonis, 6 mag., will be hidden from 10h. 13m. to 10h. 31m.

ARITHMETICAL RECREATIONS.

The following paper, communicated by M. Plateau to the Belgian Academy, is translated from *Cosmos,* and will not fail to interest a large circle of our readers by its exhibition of amusing and unexpected properties of numbers :—

M. Plateau states that a long while ago he heard the following recreative problem proposed :—Given as a multiplicand the curious number 12,345,679, it is required to find a multiplier which shall furnish a product entirely composed of a repetition of any one number, chosen at pleasure. If the figure required to be repeated in the product be 1, the multiplier required will be 9. If the repeated figure is 2, 3, 4, etc., the multiplier must be the product of 9 multiplied by such figure. Thus, to have a product consisting of 2 repeated in succession, the multiplier must be $9 \times 2 = 18$; and to obtain a repetition of *threes,* it must be $9 \times 3 = 27$, etc.

Mr. Plateau supplies the following general rule applied to this class of proposition, and he believes it to be his own discovery :—

Any unequal number being given as a multiplicand, provided it does not terminate in 5, it is always possible to find another number as a multiplier which shall give, with the former, a product composed entirely of the iteration of any figure that may be named.

To do this, divide unity by the number given as a multiplicand, which will give a periodic decimal fraction, in which the period will commence immediately after the point, it being understood that the ciphers preceding the significant figures belong to the period.

If the number given be not divisible by 3, the period will be divisible by 9; make this division, and the quotient will be the factor sought, taken singly, or multiplied by 2, 3, 4, according as the product is required to be composed of *ones, twos, threes, fours,* etc. If the number given be divisible by

3, and not by 9, the period may not be divisible by 9, but it may be by 3, and in this case divide the whole of the three periods by 9, and the quotient will be the factor sought.

Lastly, if the number given be divisible neither by 9 nor by 3, divide by 9 the whole of 9 periods, and the quotient will be the factor sought.

If, for example, N be the number given—subject to the condition of its being uneven, and not terminated by 5—and we convert $\frac{1}{N}$ into a periodic fraction, and if we represent the period by P, we shall have

$$\frac{1}{N} = \frac{P}{999\ldots.}$$ from whence we obtain $999\ldots. = P\,N$.

If the number N is not divisible by 9, the period P will be so. In this case let us call Q the quotient of $P \times 9$, and we shall have $111\ldots.. = 2\,N$, and we shall find the factor which is sought.

As for the case in which N is a multiple of 3 or of 9, and in which P may consequently be divisible by 9, it is plain that we have only to take, instead of P, the reunion of three or nine periods, so that the whole may be divisible by 9. For example: suppose the number given be 7, we find $\frac{1}{7} = 0{,}142{,}857,\ 142{,}857\ \ldots\ldots$; the factor sought will be $\frac{142{,}857}{9} = 15{,}873$; and, in fact, 15,873 multiplied by 7, gives 111,111; and twice 15,873, or 31,746, multiplied by 7, gives 222,222, etc.

If the number given be 3, we have $\frac{1}{3} = 0{,}3333\ \ldots\ldots.$; and the period is divisible by 3, but not by 9, we therefore divide by the reunion of three periods—that is to say, 333, and the quotient 37 will be the factor required.

If 27 be the number given, the period will be 037, which is neither divisible by 9 nor 3, and consequently we must take the reunion of nine of these periods to divide by 9, which gives the number 411,522, 633,744, 855,967, 0,781,893.

We see by this last example that for a small number given as multiplicand, we may require a very high multiplier; but, on the other hand, a high multiplicand may require a small multiplier, as, if the great number just recited had been that given as a multiplicand, we should have found 27 as the multiplier.

THE GENUS FISSIDENS; OR, THE FLAT FORK-MOSSES.

BY M. G. CAMPBELL.

THE Fissidentes, like their toothed allies which we considered last month, are perennial plants, and grow on the ground, or on rocks, but rarely on the bark of trees. Their foliage, however, bears no resemblance to that of the Dicranums, being, instead of setaceous and secund, flattened, the upper part expanded into a vertical scalpelliform lamina, and inserted in two opposite rows alternately on the opposite sides of the stem, or *rachis;* for this arrangement gives a frond-like appearance to the stem.

Indeed, the peculiar and highly curious structure and disposition of the leaves of this genus very naturally separate it from all other British mosses with which we have any acquaintance, while the insertion of the fruit seems to make it a connecting link between the *Acrocarpous* and *Pleurocarpous* sections; the capsule in some species being terminal, in others lateral, arising from a short fertile ramulus, to which arrangement Wilson gives the term *Cladocarpous.*

The singular structure of the leaves, besides their being vertical, consists in an expansion of tissue from the nerve, and a prolongation of one of the wings of the true leaf, making the leaf, on the stem side, double from above the middle to the base, the expanding wing clasping the stem. This is more conspicuous in the upper leaves, the length of the wing gradually diminishing, and the lower being almost destitute of this strange appendage.

The author above named enumerates and describes in his valuable *Bryologia Britannica* eight species of Fissidens, most of which may be found in fruit during this month. They derive their generic name from the Latin fissus, *split,* and dens, *a tooth.*

Among the most common is *Fissidens taxifolius,* or the yew-leaved flat fork-moss. It inhabits moist, shady banks, chiefly in a clayey soil. The inflorescence is monoicous; the gemmiform barren flower sitting at the base of the fertile stem. The stems are branched, and fasciculate, *i.e.,* with short lateral branches of unequal height; the taller in this instance are about half an inch long; they are clustered several together from a common rooting base, where both barren and fertile flowers originate. The leaves are crowded, lanceolate, apiculate, very minutely crenulate, of a light green, not twisted

when dry, and with a pellucid nerve extending almost to the apex, the dorsal wing broad to the base, but not decurrent. As in the rest of the genus, they are *equitant, i.e.*, inserted in two ranks, the leaves of each rank partly sheathing each other at the base of the leaf.

The seta arises from near the root to about, or rather more than half an inch in height, is flexuose, curved at the top, and its perichetial leaves are pointed, convolute, ovate, and sheathing; the capsule is oblong, or obovate, inclined or horizontal, of thick texture, constricted below the mouth when dry, reddish brown; the lid convex at the base, with a beak nearly as long as the capsule; the calyptra whitish, rather longer than the lid, and dimidiate, or splitting along one side. The oblong vaginula is distinct, and not insensibly passing into the perichetial ramulus as in truly pleurocarpous mosses.

FISSIDENS TAXIFOLIUS.

The illustration given is, of course, considerably magnified.

Another example of the cladocarps, and looking at first sight much more like a pleurocarp, is *Fissidens adiantoides*, or the marsh flat fork-moss, the smaller forms of which somewhat resemble *F. taxifolius*, from which however it is clearly distinguished by the position of the fruit stalk, which is lateral at a considerable distance from the base of the main stem, which latter is elongated and branched, with crowded, ovate, lanceolate leaves, denticulate at the apex, minutely serrulate below, and nerved to the point. In moist situations the stem reaches more than two inches in length, with dark green leaves and sub-fasciculate branches, more loosely cæspitose; in dryer situations it is shorter and more densely tufted. The leaves are crisped and incurved when dry. The fruit stalks rise from about the middle of the stem to from half an inch to an inch in length. The capsule is more or less inclined, of thick texture, constricted below the mouth, and somewhat turbinate when dry. The lid with a long beak, and the calyptra still longer. Its favourite habitats are shady banks, wet pastures and bogs, and on wet rocks near waterfalls.

We have found it in great abundance on a rock just above Longfords Lake, under the shade of trees in Gatcombe Wood, Gloucestershire.

As an example of the terminal-fruited section, we may instance the common flat fork-moss, *Fissidens bryoides,* to be met with almost everywhere, even in the sandy deserts of Africa, where its exquisite beauty and wondrous structure spoke so eloquently to the heart of the renowned traveller, Mungo Park, at a time when, worn with fatigue, plundered by banditti, and surrounded by all the horrors of the desert, his sinking courage had well-nigh failed, and he threw himself down to rest his weary limbs and ponder on his destitute condition. He says himself, after describing his state—"At this moment, painful as my reflections were, the extraordinary beauty of a small moss irresistibly caught my eye; and though the whole plant was not larger than the tip of one of my fingers, I could not contemplate the delicate conformation of the roots, leaves, etc., without admiration. Can that Being, I thought, who planted, watered, and brought to perfection, in this obscure part of the world, a thing of so small importance, look with unconcern upon the situation and sufferings of creatures formed after his own image? Surely not! Reflections such as these would not allow me to despair. I started up, and disregarding both hunger and fatigue, travelled forwards, assured that relief was at hand, and I was not disappointed."

Such is Mungo Park's own account of the incident, and from original specimens of the moss given by his brother-in-law, Mr. Dickson, to our celebrated botanist Hooker, the latter was able to ascertain the species as *Fissidens bryoides,* which we will now proceed briefly to describe. The general structure and arrangement of its leaves sufficiently characterize the family group to which it belongs, but it is smaller than either of those already noticed, the stems rarely averaging more than from two lines to half an inch long. The barren flowers are numerous, gemmiform and axillary, never terminal, which the fertile flower is, producing a symmetrical capsule on a red seta, and having a red peristome with a persistent rudimentary annulus and a rostellate lid. The leaves are spreading, widely lanceolate, apiculate, and with a thick cartilaginous border. It is met with in fructification at various seasons, but particularly in the winter months, December, January, and February, and its exquisite beauty cannot fail to strike with admiration any one who will bestow upon it an attentive examination. All the family, in common with the Dicranums, possess sixteen bifid teeth. For a description of the latter, see the INTELLECTUAL OBSERVER for November.

The remaining members of the group are *F. exilis,* slender

flat fork-moss; *F. viridulus*, green flat fork-moss; *F. osmundoides*, Alpine flat fork-moss; *F. asplenoides*, fern-like flat fork-moss; these all having terminal fructification; and *F. tamarindifolius*, short-leaved flat fork-moss, with an axillary cladocarpous fructification.

THE PHILOSOPHY OF EARTHQUAKES.*

In our last number we collated the principal facts connected with the British earthquake of October, 1863, and made a few observations, preliminary to a more particular study of this class of convulsions. Let us, in resuming the inquiry, first endeavour to form some conception of the earth, or rather of its crust, or outer portion, as a *whole*. We must not figure it as a quiescent body, which would be far from the truth, but regard it as undergoing incessant change, under the action of forces operating in different directions, and producing contrasted effects. For two thousand years astronomers know that our globe has made no change in its diameter sufficient to produce any recognizable effect, and it may have been equally still in this respect through time-periods of inconceivable extent. Yet we cannot imagine that at any time its various formations were absolutely at rest. On the surface, rivers are constantly carrying down to the sea myriads of tons of solid matter taken from adjacent lands; atmospheric influences disintegrate and crumble various rocks, and other agencies constantly take to pieces the structure that exists. On the other hand fresh strata and fresh structures are being formed, with equal continuity of operation, and if one set of forces tend to pull down and level, another set of forces produce upheavals and diversities of height.

Sir Charles Lyell gives a beautiful illustration of this action and counter action of forces, when he instances the case of a large river bringing down sediment which gradually fills up a sea hollow 2000 feet deep. If elevation then takes place to the extent of 2000 feet, we shall have a mountain of that height; but if our sea bed had been raised before the 2000 feet of river sediment had been deposited, instead of a mountain we should only have had a shoal. Thus, when earthquakes are

* *The First Principles of Observational Seismology*, as Developed in the Report to the Royal Society of London of the Expedition made by command of the Society into the interior of the Kingdom of Naples to investigate the circumstances of the great Earthquake of December, 1857, by Robert Mallet, C.E., F.R.S., F.G.S., M.R.I.A., etc., etc. Two vols. *Chapman & Hall.*

British Association Earthquake Catalogue. Taylor & Francis.

connected with movements of elevation, their operations are often such as to cause the levelling power of water to counteract itself; and although the idea may appear paradoxical, we may be sure whenever we find hills and mountains composed of stratified deposits, that such inequalities of the surface would have had no existence if water, at some former period, had not been labouring to reduce the earth's surface to one level.* It does not, however, follow that the *average* action of earthquakes is one of elevation, although they are plainly connected with movements that often have that effect. When there are great hollows resulting from the outpouring of subterranean matter by volcanoes and mineral springs, or from the solidification of enormous masses of rock, severe shakings must tend to convey matter from the surface towards the interior of such hollows, and in such cases earthquakes will exert a depressing effect. It is obvious that if actions of degradation went on for long periods unchecked, the earth would become an uninhabitable flat, while if the opposite movements of elevation were not counteracted for an equally long period, the mean diameter of the globe would increase, and the surface would become like a huge irregular bubble, destined ultimately to sudden and disastrous collapse. The existence of the animals and vegetables that inhabit our globe is strictly, though by no means exclusively, dependent upon the class of forces to which earthquakes belong, and therefore Sir C. Lyell is justified in affirming that "they are agents of a conservative principle, above all others essential to the stability of the system."

The earth's permanence is the result of forces, every one of which is engaged in destroying a previous condition of things, and introducing a new one; but which are so antagonised and balanced as to leave it substantially the same. We need not now speculate on those residues of unbalanced forces which may ultimately change it altogether, as their operation is infinitesimally slow, and can only become sensible after the lapse of time-periods utterly beyond our grasp. They also belong to the *cosmos* as a whole, and not specially to our minute speck of it; and if our sun, with all his attendant worlds, should ultimately pass into another form, it would no doubt be in obedience to laws as conservative of the entire universe as earthquake laws are conservative of our terrestrial sphere.

If the reader has followed this argument, he will be prepared to deal with earthquakes as phenomena of order, and to learn that the exact calculations of the mathematician are found applicable to them, so far as their conditions can be made out. He will also be prepared to discriminate between actual shocks or concussions, and the tumbling in, or slipping down

* *Principles of Geology*, 9th edition, p. 564.

of unsupported strata, which may take place in consequence of an earthquake, or may occur without its aid.

If we look at the Seismographic ("Quake-descriptive") map of the world, drawn by Messrs. Robert and William Mallet, and published in the *British Association Catalogue*, we see some connection between the principal lines of earthquake action—and the great mountain chains. We likewise see that our islands—although not far from Iceland, in which such action is violent, or from Southern Italy, in which it produces very serious effects—lie in a region of comparative calm, which is not likely to be exchanged for one of earthquake storm, except by the very slow operation of causes, which would alter the physical geography of our portion of the globe.

Hereafter, when men know better how to guard against the perils of earthquakes, highly industrious and civilized communities may live in regions subject to severe shocks; but the chief seats of progressive races have hitherto been in places tolerably secure. But, notwithstanding their dangerous character, when shocks are frequent, people get so used to them, that Humboldt tells us of districts in South America "in which the inhabitants take no more notice of the number of earthquakes than we in Europe of that of showers of rain," and where, he adds, Bonpland and himself were compelled to dismount on account of the restiveness of their mules, "because the earth shook in a forest for fifteen to eighteen minutes without interruption." Of such localities Sir C. Lyell well observes, that "where earthquakes are frequent, there never can be perfect security of property under the best government; industry cannot be assured of reaping the reward of its labour, and the most daring acts of outrage may be perpetrated with impunity when the arm of the law is paralyzed by general consternation. It is hardly necessary to add that the progress of civilization and national wealth must be retarded by convulsions, which level cities to the ground, destroy harbours, make roads impassable, and cause the most cultivated valley plains to be covered with lakes, or the ruins of adjoining hills."

The bands of seismic influence "very generally follow the lines of elevation which mark and divide the great oceanic or terr-oceanic basins (saucers) of the earth's surface. And, in so far as these are frequently the lines of mountain chains, and these latter those of volcanic vents, so the seismic bands are found to follow them likewise." Thus says the *British Association Catalogue*, and it adds, that "the surfaces of minimum, or of no known disturbance, are the central areas of great oceanic or terr-oceanic basins, or saucers, and the greater islands existing in shallow seas." The Ganges and Mississippi river basins, as explained, do not conflict with this last proposition, as when

the mountain ridges "are very large in relation to the basin, the breadth of the seismic band may overlap the whole surface."

If, from these general considerations we proceed to study the particular phenomena of earthquakes, we find that the fundamental propositions laid down in Mr. Mallet's *Seismology* are, that "the elastic wave or earth shock may reach a given point upon the surface with any angle of emergence (the angle contained by the horizontal plane with the wave path at the point of emergence), or in any azimuth. The path of the wave is a right line, joining that point with the centre of impulse (or focus), the wave being assumed to be propagated from thence in all directions in spherical shells. This is strictly true only in a homogeneous elastic solid." We dare say this will appear very unintelligible to persons unaccustomed to such considerations; but it will soon become plain. Draw a large circle on a sheet of paper, and let this represent a solid globe. Then draw a small circle in the middle of it, and let this represent a hollow place. Then imagine a little gunpowder ignited in the centre of the hollow. Its explosion would strike the walls of the hollow equally in all directions. Suppose the walls elastic, and too strong for the explosion to break; they would still experience a shake all round, and they would in turn shake the neighbouring particles all round, and these again another set, and so on, producing concussion waves, one outside the other, and forming what Mr. Mallet calls "spherical shells." Thus a number of circles drawn outside the circle bounding the hollow would represent these "shells," and, if continued long enough, they would extend to the large outer circle of all. Draw a horizontal line, touching this circle, and then, from the same centre as all the former circles, draw a great circle cutting the horizontal line, and this will represent the concussion wave emerging at the surface of the earth.

Such a diagram, made without any difficulty, will explain to the eye how concussion waves, starting in all directions from a point below the earth's surface, widen and widen their circles, until they reach that surface.

The next essential thing is to learn what is meant by the "seismic vertical," and we perceive its nature if we draw a line from the centre of the hollow, or point from which the concussion proceeded, up to the horizontal line representing the earth's surface, and falling *perpendicularly* upon it. To obtain another illustration of this matter, give the under side of a table a tap with a small hammer; whatever is placed exactly above the hammer on the table, so that the concussion would throw it straight up in the air, is in the seismic vertical, and

if the shock communicated is not very violent, and the object not top-heavy, it will not be overthrown, but simply raised, to fall back where it was before. But any hammer stroke will have given a concussion to the whole table—one concussion wave after another will spread, like those produced by throwing a stone in a pond—and they will reach the surface and emerge further and further off the centre of the shock and the seismic vertical, each one coming out more slantingly than that which preceded it. Thus we might draw on the surface of the table concentric circles, each representing the crest of a concussion wave, the waves growing weaker and weaker as they extend further and further from the original point of shock. Every circle thus traced would represent a line of equal shock, or, in technical terms, a *co-seismal line*; that is to say, a line on which objects would be equally shaken on whatever part of it they might happen to be placed.

Having thus formed an idea of lines of *equal shock*, we must consider the line of *maximum shock*, or, rather, maximum power of overthrowing objects. A body like a sugar-loaf, or a skittle, would not be readily overthrown by striking the table immediately under it. The blow might be severe, but its direction would make it feeble in *overthrowing power*, while a concussion that reached the skittle more obliquely, though of less violence, might be quite sufficient to throw it down. We have seen that the greater the horizontal distance from the seismic vertical at which a concussion wave emerges, the greater its slant. Now, the most advantageous mode of exerting force to upset a skittle is to give it a shove *horizontally*, and above its centre of gravity; and thus the concussion wave improves the *direction* of its force as an upsetting power by slanting from the seismic vertical; but as it slants it gets further off its origin or source—its energy is spread over a greater area, and is weakened in consequence. There will, however, be a certain distance from the seismic vertical at which loss of power will be compensated by gain in direction, and a line connecting *all* such points will be the line of maximum overthrow, or *meizoseismic line*. In our illustrative diagram this may be a circle, but in nature some of our supposed conditions never occur. In real earthquakes the focus from which the disturbance proceeds will not be a point, but an irregular, and often very large space, and the surrounding earth strata will be of different structure and density, better able to transmit a shock in one direction than another. Thus we shall not find the co-seismal lines (in nature) making circular curves; but, although less regular and more difficult to trace, they will still be distinguishable when the circumstances are favourable.

To prevent a misconception, we must now advert to a fact

we omitted for simplification in our directions for diagram drawing. What is called in mechanics the *vis viva* of the concussion wave "must remain constant, and (in the same medium, its dimensions being very great) the velocity of translation also. The *mass* in wave movement, at any moment of its transit, is therefore the same, and the thickness of each successive spherical shell decreases from the centre of impulse as the square of its mean distance."* We should therefore have to make our circles less and less in the proportion specified, in order to have our diagram correct.

A very important fact to be remembered is thus stated by Mr. Mallet in his great work, when he tells us that "the distinction must be clearly borne in mind between the velocity of transit of the wave, that with which the advancing *form*, or seismal curve, is transferred from point to point of the surface, and that of the earth particles moving within the limits of the amplitude of each vibration." This will be plain enough to most of our readers, but for others whom it may perplex, it may be stated that when an elastic body is thrown into wave motion, the *force* that compels that motion travels from particle to particle *faster* than the particles themselves move. In earthquake waves, Mr. Mallet considers the velocity of the former to equal half the speed of a cannon ball, while the latter, he tells us, "is often not greater than that which a body acquires by falling from a height of two or three feet." Thus the quake will visit various localities in succession immensely quicker than it causes any body to move; were it otherwise, the stones of a building overthrown would be hurled about like cannon balls, and, weight for weight, be as destructive as they are when half their commencing velocity has been lost.

When an earthquake reaches a building, or any object whose dimensions are less than its own amplitude (or width), its first proceeding is to impart to it a motion that tends to carry the base *forward*, and thus, if the object be overthrown, it falls *backward*, if free to fall in any direction. If we knew that an earthquake was likely to come, we might arrange two rows of wooden cylinders, all of the same height, but varying in breadth, from the first in each row, broad enough to stand very firmly, to the last in each row, so slender as to be easily overthrown. If these two rows stood upon two boards at right angles to each other (as represented in the diagram, p. 98, *British Association Catalogue*) no shock could reach the earth's surface at that place without affecting them, and one set would be in such a position as to be able to fall freely *across the plank*, without touching each other, provided they were far enough apart. Suppose a bed of sand arranged for the cylinders

* *British Association Catalogue*, p. 111.

to fall in and stop their rolling, their overthrow would then give us much information.

First, we should get to know the force of the shock, because it either knocked down all, and thus was competent, or more than competent, to the hardest work we had set it, namely, to overthrow the cylinder of the broadest base; or it would knock down some, and leave others, and then we could say that it was able to upset cylinders not exceeding a known power of resistance. In the next place, we could tell the direction of the shock from that in which the cylinders fell. Now, excepting that these cylinders could not, like walls, be cracked by a concussion not sufficient to overthrow them, they would resemble, more or less, the buildings in a town, of course making allowance for difference of shape. If therefore we examine a town that has been damaged or destroyed by an earthquake, we ought to be able to learn from it what the cylinders taught, together with some other facts they could not show.

Hitherto, for the sake of simplification, we have omitted to speak definitely of the *opposite* motions of a concussion wave, which might without explanation be supposed capable of imparting movement in one direction only. The following extract from Mr. Mallet will place the composite action in a clear light. He tells us that, "as the co-seismal curve (or crest of a wave-shock) enlarges its area, travelling outwards in all directions from the seismic vertical—that is, from the vertical line passing through the earth's surface (and centre) and the focus—every point in and upon the surface, in succession, moves *once forward and back* in the direction of the wave-path, and to the extent of its amplitude at that point, or in two components, vertical and horizontal, that shall give such direction." An object may be overthrown by either the backward or the forward motion, and when the concussion wave emerges in a slant, the form of the body and its mode of standing, or being supported, will determine whether the forward or the backward motion is most dangerous to it.

When an earthquake makes an onslaught upon a town, tall, old, badly-built edifices may be reduced to a heap of ruins, while stronger buildings escape with slighter injury. In narrow streets of weak houses, a smart shock throws some down first, and they in falling tumble against neighbouring structures, and reduce the abodes of thousands to a pell-mell heap of rubbish, from which little more than the magnitude of the calamity can be learnt. When the buildings are stronger, and less affected by the disasters that happen to adjacent edifices, the work of devastation is more methodical, and frequently goes no further than the production of cracks, or fissures, indi-

cating that a measurable quantity of masonry has been moved in one or more given directions.

Such cracks are invaluable to the seismologist, and if he can find enough of them, he interprets their silent language into a veritable history of the shock. By the direction of the cracks he learns which way the concussion came; by the quantity of displacement work done he estimates its force, and from a sufficient collection of details he draws his curved lines of *meizoseismal* or greatest overthrow, and *isoseismal* or equal overthrow. A few points on a co-seismal line will also enable him to determine the seismic vertical, or the line perpendicularly over the focus of the disturbance. For reasons already explained, none of the isoseismal lines will be circles, nor will the focus of concussion appear as a single point. If, however, we may judge from the success with which Mr. Mallet investigated the Neapolitan earthquake of 1857, the practical application of seismological principles is easier than might be supposed, and bids fair, when extended to a sufficient number of concussions, to throw a valuable light upon these commotions in the crust of our globe.

We cannot attempt to indicate all the important questions discussed with great ability in Mr. Mallet's work, but we will endeavour to supply a sufficient quantity of elementary material to assist those who might, without such aid, find the work itself somewhat beyond their grasp, and to afford to others, who do not desire to fathom the subject, as much information as they will need. We must, however, recommend all to consult the book for themselves, because those who do not desire to *study* it will gain a great deal by reading portions and carefully examining the large number of beautiful and instructive plates. Proceeding with our necessarily imperfect sketch, let us inquire into the velocity of earthquake shocks. Mr. Mallet informs us that "the power of the wave-shock to produce overthrow depends upon the intensity of the wave, that is upon its amplitude, and upon the elasticity of the medium in its passing through, conjointly; and as all free displaced bodies must be displaced to the extent due to the greatest velocity impressed at the centre of gravity, the measure of such displacement is always that of the velocity of the wave particle at its maximum." In the endeavour to determine these velocities, Mr. Mallet found the cases divided into three groups: the first, in which the true wave velocity and its result were not much interfered with by surface oscillations; the second, in which the *velocity ascertained* "was made up of the true wave velocity plus that of the elastic oscillation of the surface at the displacing point," and thus was greater than the

true wave velocity; and thirdly, when from some cause the determination was below the truth.

The mean velocity of ten determinations was found to be 12·039 feet per second, of which the highest was experienced by a vase projected from a gate of the prince's garden at Certosa. This exceeded twenty-one feet, "but at least eight feet per second was due to the elastic oscillation at the top of the pier itself." A little hill, *colline*, at Saponara, appears to have had a velocity of oscillation = 1·724 per second. These low velocities did not coincide with preconceived ideas; but Mr. Mallet observes, that we are by no means to consider twelve or thirteen feet per second as the greatest possible velocity of an earthquake shock, as when the town of Riobamba was totally destroyed, Humboldt informs us that the bodies of many of the inhabitants were thrown upon the hill of La Calla, which rises to the height of several hundred feet at the other side of the Lican torrent. "The actual range of vertical projection of these bodies has been estimated at 100 feet. The velocity due to this height of projection is $V = \sqrt{2g}\,H = 80$ feet per second; and this is probably the greatest velocity of shock recorded, or perhaps at present possible upon our earth; it is nearly as great as that with which the body of one who should leap from the top of the Duke of York's column at London would strike the pavement; and taking the greatest *velocity* that we have ascertained for this (the Neapolitan earthquake) at fifteen feet per second, this maximum velocity is $\frac{80}{15}, = 5{\cdot}33$ times greater than the velocity of our Neapolitan shock."

Bearing in mind the probable identity of the causes of earthquakes and volcanoes, it is evident that the height of volcanic cones should be proportioned to the earthquake intensity, and Mr. Mallet finds that the velocity of the Riobamba shock exceeds that of the Naples shock as much as the Andes are higher than Vesuvius.

If the focus of an earthquake was always at the same depth from the surface, the area of noticeable disturbance would be a measure of the force of the shock, but very violent concussions have been known to affect very limited spaces, and in such instances the foci must have been proportionably near the surface that was disturbed. "We may generally infer from this that earthquakes, like that of Lisbon, which have *a very great area* of sensible disturbance, have also a very deep *seismal focus,* and also that *the greatest depth of seismal focus within our planet is probably not greater than that ascertained for this Neapolitan earthquake, multiplied by the ratio that the Riobamba wave bears to that of its wave;* or, what is the same thing, by the ratio of the altitudes of the volcanoes of the

Andes to that of Vesuvius." This would give 30·64 geographical miles as probably the greatest depth of origin of any earthquake.

Here we must close our explanations, strongly advising our readers to have recourse to Mr. Mallet's elaborate and magnificent work.

We subjoin a few particulars relating to the late British shock, which reached us since the publication of our last number.

FURTHER NOTES ON THE EARTHQUAKE OF OCTOBER 6TH, 1863.

Since the publication of our last number, we have collected a few additional facts relating to the earthquake of October. In the first place, positive proof has been obtained that the wave-motion was sufficient to cause a noticeable displacement of materials. Thus, a correspondent, who sends us his card, and signs himself "A. L. S.," supplies the following interesting narration. He says:—

"SIR,—On receiving this month's INTELLECTUAL OBSERVER, I was very glad to find that it contained a record of the earthquake of October 6, the article being a careful digest of the chief reliable facts which have been published.

"You remark, p. 295, 'It is not unlikely that careful inquiries would lead to the discovery of fissures in old and weak buildings,' etc.; and with reference to this I select the following accounts from amongst a large number, and which, being definite and reliable, may be thought sufficiently interesting to your readers to merit a place amongst the 'Notes and Memoranda' next month.

"I have received and arranged 138 reports from 122 places; and so far as they show, it would appear that the shock was felt at and near the village of Garway—situated twelve miles from Ross, Herefordshire—with more severity than in any other locality. At this place, the house of Mr. Herbert suffered most; it is built of stone, has only a shallow foundation, and stands in a valley close to the river, nearly facing the cardinal points of the compass. The south wall was split from top to bottom, the direction of the crack being *from* east at the bottom. The crack has since increased, and the stone is loosened. The walls of all the top rooms were cracked, and one whole brick and three half bricks fell down a chimney into one of the rooms. At the house of Mr. Herbert, jun., in the same place, all the top room walls are cracked, also the ceilings, and a portion of one ceiling fell. The shock is described as uplifting and vibrating; the sensation, as if the bed were being lifted by its corners; and its violence was sufficient to throw a pair of candlesticks off a table. Domestic animals shared largely in the general terror, pigs shrieked violently, and eight farm-horses, which had been turned out for the night, galloped home.

"As tending to show the direction of the motion, the following

may also be useful:—In the lower part of the town of Ross, Herefordshire, the wife of a rev. gentleman was sitting up with an infant; she observed the west wall of the house perceptibly lean towards her, as if falling, and a chair was tilted off two legs in the same direction, nearly four inches. The large doors of a wardrobe, which were unfastened, were thrown open by the movement. The article stood back to the east, in the house of a medical doctor, also at Ross."

We are also indebted to the Rev. T. W. Webb for further particulars of occurrences in his district (Hay, South Wales), which show that the vertical component of the shock was strikingly exhibited. Thus, a man who was sleeping on an earthen floor in a valley of the Black Mountain, saw a board that was beside him struck up from the floor, and sundry three-legged tables and other heavy pieces of furniture were set "jigging," as the folks described it. A cottager's wife told Mr. Webb, that after the shaking of her bed in a room up one pair of stairs, and the "jigging" of a three-legged table at the foot of it had both *ceased*, she distinctly heard the chairs moved about in the ground-floor room underneath. In this case the first semi-phase of the vibration affected her room, and the second semi-phase operated more especially below. At same place in South Wales, the vertical component of the shock appears to have been strong enough to give a momentary *lift* to a gasometer, by which action gaslights were put out. At Cheltenham, the police were terrified by the clanking of the iron gates of the cemetery. Books were likewise thrown down from unfilled shelves, and pictures moved out of their proper positions, and left all awry. Mr. Webb also furnishes us with an extract from a Hereford paper, describing what occurred at Llandefailog Vach, about two miles north of Brecon. It states that at Glanhondda House a ceiling was cracked across, also one of the walls of Llandefailog House. The arch of one of the chancel windows in the church was forced apart some inches, the glass damaged, and a good deal of plaster torn off the wall. A ceiling was also cracked, and some tiles displaced, at Hereford.

It will be evident that if any person competent to apply the theorems of Mr. Mallet's book visited these localities, the probable depth of the focus of the shock might be ascertained.

In London and its neighbourhood a few remarkable things occurred. Thus, at the Greenwich Observatory, the Astronomer Royal states that one of his assistants, who was observing the collimation of the wires of the altazimuth, perceived the mark at which he was looking to move in an extraordinary manner, so that he thought the wall to which it was attached must be in motion. In Camden Crescent, N. W., a lady, whose hus-

band was out, was so convinced that some one was lifting up her bed, that she jumped out, and took refuge in another lady's apartment. Another lady, in the same locality, experienced a similar sensation in her bed; but she informs us that the china and glass articles on the wash-hand stand were quiet, although the passing of a railway train frequently makes them jingle.

Mr. Shirley Hibberd contributes the following letter:—

"My residence at Stoke Newington is on a clay soil, overlying a deep stratum of sand. It has recently, on the south side, been connected with a branch of the northern high level sewer. In the house are a few foreign birds, and amongst them a pair of Australian ground paroquets, which occupy a cage in a parlour on the south side of the house. My bed-room is on the north side, where all the brickwork of the foundation is in immediate contiguity with the clay, whereas on the other side the foundations comprise a considerable extent of cellarage and tunnelling. On the morning of the 6th of October I was sitting beside a cheerful fire in the bed-room, writing till some time after three a.m. I then turned down the lamp, and got into bed, and almost immediately got out again, and hurried down with the lamp in my hand to receive a supposed visitor, who appeared to have entered at a bound. Mrs. Hibberd was full awake at the time, and the impression she received from the disturbance was that a burglar had entered at the window of the parlour where the paroquets are kept; and, stepping on the edge of the table, had come down, table and all, with a crash. There has not been much said about the effect of the earthquake on animals, and I mention my birds in order to say that the alarm occasioned by the shock was sustained by the paroquets, which commenced screaming most vociferously, and as I never heard them before. The search for burglars required me to pass "Old Poll," who was awake and listening; "Trot," the cockatoo, who was ditto. I next passed my meteorological instruments, which I always look at from habit, under any and every circumstance, and I noticed that the barometer had not moved a hair's-breadth since last marked eighteen hours previously. I next encountered the screaming birds, expecting to find with them a grim human intruder. The poor birds were fluttering and screaming in a most painful manner, but a few kind words composed them, and once more we were quiet. The next occurrence was a repetition of the original shock in a very subdued manner—a sort of dull "thud;" then we noticed simultaneously that some large trees near the house were shedding their leaves, as if agitated by wind, though there was not a breath stirring. The time of these occurrences was between 3·20 and 3·30; the exact time was not noted, for the idea of burglars was so distinctly before our minds that our attention was almost wholly directed to discover whether we were really favoured with an inquisitive visitor. Had I suspected an earthquake, I might, being awake at the time, having a second witness at hand, having also a fire, light, time-piece, barometer, and other

aids to observation within reach, have made some better use of the occurrence than I did; but who in these prosy times ever thinks of an earthquake till it is all over?"

The fact that some persons were strongly affected by the concussion, while others in adjacent houses did not notice it, need not surprise us when we take into consideration individual peculiarities of sensitiveness, occupation at the time, etc., etc., and also bear in mind the very different conducting power of hard and soft soils, and of various kinds of masonry. The beds or furniture in some houses would be in a more favourable line of disturbance than in others. In Mr. Hibberd's case the brickwork of the great drain may have conducted the shock to the foundations and walls of his house. A correspondent in the *Times* states that a strong shock occurred in Antigua at a period corresponding with 6th October, 2·28 a.m. English mean time. Further facts would be necessary to show whether this was a mere coincidence, or an indication of the range of the shock which these islands felt.

MOUNTING DRY OBJECTS.

BY T. W. WONFOR,

Hon. Sec. Brighton and Sussex Natural History Society.

We have received the following valuable letter from Mr. Wonfor. His method appears to be well worth trial, but great care must be taken in making the brass and glass surfaces quite clean. One of the cells he was kind enough to send loosened in transit. Probably attention to the surfaces and the use of marine glue would secure success:—

"Knowing the interest you take in all matters relating to the microscope, I have taken the liberty of addressing you upon a paragraph in this month's Intellectual Observer. The plan proposed by Mr. Ralf for dry mounting I tried some eighteen months since, and found it open to three objections. First, Heat does not perfectly unite the gutta-percha and glass; consequently a mere touch will remove the cell. Secondly, If there be the least moisture about the object, glass, or gutta-percha, it rises and dims the covering glass. Thirdly, Gutta-percha seems an admirable *nidus* for the production of microscopic fungi, as numerous slides spoilt by their growth testify.

"Gutta-percha cells, fastened with cement, are also liable to come off with a touch, and if employed must be painted inside with Brunswick black, etc.; by this means the growth of fungi is avoided. A cheap and more permanent form of cell can be made out of brass curtain-rings, which may be had from one-

quarter of an inch diameter upwards. They can either be flattened with a hammer, or rubbed flat on both sides on a stone, and fastened with 'liquid glue,' 'Bell's cement,' 'marine glue,' or any other cement used for fastening brass to glass. The rings cost from 8*d.* to 10*d.* a gross.

"If they are painted with Brunswick black afterwards, the brass is concealed, and they present the appearance of deep cement cells. The readiest plan I find is to prepare two or more dozen at a time; and as most opaque objects require a dark background, my punches, purchased for cutting gutta-percha, came in useful for cutting black patches.

"I send you a plain cell, one with cement and patch ready to receive an object, and another complete. For deeper cells I get a brass-turner to cut brass-tubing to the required depth. The same objection as regards fungi applies to the interior of ivory cells."

A NEW REVERSIBLE COMPRESSORIUM.

It is not long since we had occasion to notice a very excellent compressorium, devised and manufactured by Mr. Ross. It was worked by a single screw, afforded great facility for replacing the upper thin glass, and permitted the lower and thicker one to be removed, so that any object might be conveniently prepared upon it, under water if necessary. This compressorium, it seemed to us, might advantageously replace the live box, being quite as easily used, and very superior to it whenever delicacy of manipulation is required. But, notwithstanding the merits of this, and of certain other forms of the compressorium as constructed by other makers, there was still room for a new one, to meet requirements that are by no means uncommon in microscopic pursuits.

M. Quatrefage, by placing two brass pins upon the old lever compressorium, enabled the instrument to be reversed, so as to give a view of both sides of an object; but there was no provision to secure parallelism of pressure, and it had other important defects. Dr. Carpenter, in the last edition of his work on the Microscope, observed that, in his opinion, nothing could be more suitable to ordinary purposes than an equatic box having a screw collar fitted to it in such a manner that by turning this its cover may be pressed down or raised up as gradually as may be desired, without any rotation of the cover itself or any disturbance of the parallelism of the glasses. This is the character of the new reversible compressorium contrived by Mr. Slack and Mr. Richard Beck, and now manufactured by

the firm of Smith, Beck, and Beck, but it is more complete than that suggested by Dr. Carpenter. It consists essentially of a very flat screw live box, having a special contrivance to prevent the rotation of the compressing plate, and furnished with springs which elevate the upper plate the instant the tightening of the screw is relaxed. It is so thin that it offers no obstacle to the employment of the achromatic condenser or the parabolic illuminator, and requires no change in the adjustment of the illuminating apparatus when it is reversed.

Another important peculiarity in this compressorium is the way in which the upper and lower glasses are inserted, and the adaptation of the instrument to receive them either moderately thick or extremely thin. The glasses are kept in their places by a slight pressure of four flat-headed screws, two for each. These screws can be instantly turned by a small pair of pliers, or by the finger and thumb, and allow a glass to be replaced or exchanged without a minute's delay. This we regard as a point of great practical value, as much time is lost when the glasses are cemented in. In addition to replacing broken glasses it is frequently desirable to change them, as the very thin glass necessary for high powers will not bear the strain that is inevitable, when many objects that are intended to be examined with lower powers have to be compressed. With the new compressorium thicker plates, top and bottom, can be substituted for thin, or *vice versa*, at a moment's notice, and Messrs. Smith and Beck can, if required, supply two or more of the compressing apparatus to fit the same bed, and thus two or more thicknesses of glass may be always ready for use.

The new compressorium was shown at the October meeting of the Microscopical Society of London, and met with approbation from those who examined it; but we purposely delayed noticing it to see if we could discover any practical defect. We have now employed it on many occasions with frequent change of glasses and with high and low powers, and it appears to us to fulfil more completely than any other compressorium we are acquainted, the varied requirements with which such an instrument is usually employed. In the details of its arrangement there are many little pieces of clever contrivance that would not be intelligible without diagrams, but we have explained the main features of the instrument, which is simple, convenient, and strong.

While upon the subject of compressoriums we may remark that, when the parallelism of the two glasses is required to be extremely perfect, as in the case of minute and very flat objects, either side of which cannot be viewed with deep objectives, care is required in the selection of the glasses, as the ordinary thin glass made for covering microscopic objects is

often very uneven. If no reversal is necessary this does not so much matter, as the bottom glass can then be carefully chosen, and thick enough to allow the upper one to be flattened upon it. When, however, two thin glasses are indispensable, as for the purpose of viewing *both* sides of an object with a $\frac{1}{12}$, $\frac{1}{20}$, or $\frac{1}{25}$, it is necessary to pick out thin glasses that will fit each other with sufficient accuracy. The glasses ordinarily supplied will seldom fail with *moderate*-sized infusoria, but anything flatter than they are needs especial care.

A VISIT TO LAPLAND.*

FEW regions of the earth exert a more powerful influence on the imagination than those countries which lie sufficiently near the North Pole to exhibit the remarkable summer phenomenon of an unsetting sun, and which are at the same time so far removed from the regions of perpetual frost as to put forth a vegetation beautiful in its flowers, and magnificent in wide-stretched forests of the sombre fir. It is, indeed, impossible to read of voyages within the picturesque portions of the arctic circle without experiencing to a greater or less extent the feeling so beautifully depicted by Longfellow in the fine story of "The Discoverer of the North Cape," which he borrowed from "King Alfred's Orosius." In that charming legend we learn how Othere, the old sea captain, "had his heart stirred up by the old seafaring men, with their sagas of the seas," until at length he could "neither eat nor sleep for thinking of these seas," and then he sailed northward from his home in Heligoland, and

> "The days grew longer and longer,
> Till they became as one,
> And southward through the haze
> He saw the sullen blaze
> Of the red midnight sun."

Strange seemed the narrative to "Alfred, king of the Saxons," and an "incredulous smile" played over his countenance as Othere continued the story of what he saw and did after passing the North Cape:

> "Four days I steered to the eastward,
> Four days without a night;
> Round in a fiery ring
> Went the great sun, oh king!
> With red and lurid light."

The astronomical puzzle does not bewilder us as it did the

* *A Spring and Summer in Lapland, with Notes on the Fauna of Luleå Lapmark*, by an "Old Bushman," author of "Bush Wanderings in Australia." London: *Groombridge and Sons.*

simple-minded king, but we cannot help the desire to witness a spectacle so startling and sublime, and to make ourselves acquainted with the life of a locality so widely different from our own.

The "Old Bushman" is a pleasant guide to these scenes of wild fascination; a certain ruggedness about him is in harmony with their uncultivated grandeur; their loneliness and remoteness from the tame conditions of civilization rouse his imagination, and he studies their fauna as a naturalist, as well as pursues them for his sport.

He tells us that the tourist who visits Lapland merely to see the country can do so without difficulty. "He will not require to leave England before the end of May; he can perform the whole journey from Hull to Happaranda (the most northerly town in the Bothnian Gulf) *viâ* Gothenburg and Stockholm by steam." There is no certainty that steamers can run the whole way till June, but when Happaranda is reached, "the journey will be performed in boats or on foot, and he will find far less difficulty in reaching the wildest spot in Lapland than he would anticipate." The naturalist, or egg collector cannot, however, manage so easily; he must be at his head-quarters in April, and must therefore steam up in the autumn before the frost sets in, and "brave the rigours and monotony of a Lap winter;" or he may adopt the "Old Bushman's" plan, "and sledge up during the winter, taking care that he is not too late, for the snow melts all at once when the thaw sets in, and just at this time travelling is dangerous, troublesome, and laborious." Our "Old Bushman" left Gardsjö on March 24th, and reached Quickiock on April 16th, having good sledging all the way except for six English miles. Sledging he describes as a very comfortable mode of progression, as good as a first-class railway carriage; but, like other travellers, he indulges in a hearty growl at the peasant carts, which are little shallow boxes stuck upon wheels, and destitute of springs. The driver hurries along over holes and ruts, and the traveller seated on a little plank is obliged "to hold on like grim Death, otherwise he is sure to be shot off his perch, every bone in his skin aching with pain." If not exactly luxurious, the locomotive arrangements in this country have the merit of being cheap, and the people are very honest, and anxious to earn a penny by rendering what aid may be required. The journey to Quickiock occupied about three weeks, during which a thousand miles were traversed, and comfortable quarters found each night. The cost for three persons and a dog was six shillings a day, and one and tenpence posting, making in the whole about £25. The scenery through which he passed is summed up in two words, "snow and pines," and very few birds of any description were seen—

"one Ural owl, one blackcock, and one Siberian jay were all that we shot, and we always had a loaded gun ready in the sledge, but neither heard of nor saw a single wolf."

Having arrived at Quickiock, the "Old Bushman" rarely wandered more than three Swedish miles from it, but in four months he obtained and skinned more than a thousand specimens, besides collecting a great many eggs and butterflies. The first impression of Lapland scenery in the winter he found very striking, but the effect wore off on acquaintance, and a wearisome sense of monotony ensued; "everywhere the view was shut in by barren fells, the tops of most of them covered with perennial snows." An old parish clerk stated that, for forty-two days in the winter, it was so dark you could not see to kill a bird with a rifle at a hundred yards, and these depressing influences act upon the manners of the people; "if you speak to them you get a half-civil answer, but nothing more—their manner is very different from the hearty welcome the stranger receives in old Wermland."

The physical geography of the neighbourhood of Quickiock is excellently sketched in the following passage:—

"The situation of Quickiock is romantic in the extreme, and in the summer it would be hard to find a place in Lapland to beat it for wild, natural scenery. Surrounded on all sides by fells and forests, yet, lying as the village does in a sheltered valley, every kind of ground is met with here, and the naturalist could hardly choose a better station. A large river, the Tara Elf, flows down the fells close by the village; the proximity of the village to the fells themselves renders it peculiarly interesting to the collector; while meadows and swamps choked with grass and every species of aquatic plants, intermixed with numerous small and natural channels, and inland lakes, afford shelter for many species of ducks; but, strange to say, there are fewer waders in this district than in any I know. The Lap forests, in general, present a strange contrast to the deep forests of Wermland and Dalecarlia. The branches of the fir trees all grow in a slanting direction downward, and as they are for the most part dead and jagged, although the trees are small, it is no easy matter to climb them; the meadows and lower grounds are covered with thick plantations of a species of willow, through which, in many places, it is impossible to force one's way, and immediately above them are the forests composed of fir. We see very little pine here, and what few pines we do see are generally blighted and bare. The higher we ascend the fell sides the smaller become the forests, till at length we miss the fir altogether and reach the birch district. On leaving this we come to the fell birch, which, exposed as the trees are to the cutting wind

in all directions, assumes every fantastic shape. At first, the fell-birch grows to a height of about four feet, but when we come higher up the fells it dwindles to a mere bush, and at length becomes nothing more than a creeper, matted and tangled on the ground; but the dwarf willow (*Salix herbacea*), the smallest shrub in the world, grows on some of the fells as high as the dwarf birch. Above this, the fells assume their true character, and are covered with lichens or mosses, and in many places with perennial snows."

The lines of vegetation are clearly defined as the traveller looks from a fell top down its sloping sides, and the fells are composed of huge masses of iron-stone and shingle, of all shapes and sizes, towering above one another, and capped with snow. During the short, but active summer, "no one, who has not seen it, can picture to himself the beauty of the valleys that lie between and at the foot of the fells themselves. Nowhere have I seen so rich a vegetation, or such a profusion of wild flowers, as bloom in this so-called wilderness; and nowhere do the wild flowers appear so beautiful as when we see them in a spot where we least expect to meet with them." . . . To stand in one of these fell valleys on a carpet of grass and moss, as soft as the richest mat Turkey can yield, variegated with wild flowers of every hue, from one to the other of which, rare and beautiful butterflies are continually flitting—to see the rugged fells themselves, frowning down in severe majesty upon one, excites a feeling of awe, perhaps, rather than admiration; and though we know that not a human being is within miles of us, we cannot call it solitude:—

"Tis but to hold
Converse with Nature's charms and view her stores unrolled."

During two summer months the nights were as light as days, and shooting could be done as well at midnight as at noon. The "Old Bushman" gives some magnificent descriptions of scenes at night, with the sun pursuing his course above the horizon; but for them, and for many details of natural history we must refer to his own pages.

The Swedish bear he found "a very well-behaved animal" if unmolested, and wolves are by no means plentiful. The quadrupeds and the fish occupied a fair share of the "Old Bushman's" attention, but birds and eggs were the principal objects of his pursuit. About March 1st he tells us the ice and snow began to melt; on the 10th of April the snow bunting appeared; on the 25th, wild geese, swans, and larks, arrived. The papillio (vanessa?) urticæ was seen, and patches of bare ground appeared. On the 1st of May came the white wagtail; on the 24th the marsh marigold was in flower; on the 28th the birch in leaf. June is a warm month, but night

frosts appear in August, and by the 20th of September the birch sheds its leaves, and by Michaelmas the first snow-storm usually arrives.

While in Quickiock, the "Old Bushman" was so fortunate as to witness a migration of lemmings, and, as might be expected, he strips off a great many improbable particulars which romancing travellers have been in the habit of adding by way of illustration to the actual proceedings of these elegant little animals. They usually journeyed by night, did very little harm, and were not in the habit of climbing walls or entering buildings of any kind.

As a book for general reading, the *Spring and Summer in Lapland* will be found one of the pleasantest of the season. Its author has a strong, native faculty for seeing and describing, and is so happily ignorant of the mere craft of bookmaking, that his pages are as far removed from commonplace as the genuine products of the Lapland fells. It is, however, as an ornithologist that he will be most appreciated by scientific men, and his chapters on these subjects are filled with original observations that evince an earnest desire for truth as well as unusual aptitude for this species of research. We shall give only one extract from this part of his work, but those who seek its pages for themselves will find abundance of material that is important and new. Our closing citation relates to the disputed question of the moulting of the ptarmigan. It runs as follows:—

"The question now arises, how many times can the ptarmigan be said really to moult in the course of a year? I don't mean change colour, for a change seems to be going on all through the summer, but *actually to moult*. . . It is quite clear to me that the change from the pure white winter dress to the mottled plumage of spring is an *actual moult*, and no change in the colouring of the feathers; for in all the specimens I obtained from the middle of April to the end of May, the variegated mottled feathers were to be seen, of all sizes, shooting out from the skin, with blood shafts among and under the white feathers in all parts of the body, some very small and quite hidden by the white plumage, others full grown and occupying patches on the white ground. In not one of these specimens killed at this time could I observe the slightest indication of a white feather gradually changing colour." The autumn dress he considers also the result of a perfect moult, as he observed a growth of new feathers late in July and early in August, and he likewise considers the change from the blue dress of autumn to the white one of winter another moult, this making three moults between April and November. This opinion he gives advisedly, but states that he shall be willing to change it, if evidence appears that he is wrong.

NOTES ON THE VIBRIO FAMILY.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopic Society of London.

In my remarks on the vinegar plant in the last number of the Intellectual Observer, I expressed doubts, which I believe most microscopists feel, with respect to the naming and identifying of the various objects that may be roughly described as belonging to the so-called Vibrio family; and while acceding generally to the views of M. Pasteur, that such bodies are agents of putrefaction and fermentation, I observed that if his statements should be confirmed, and it should be found that one set of these bodies live in oxygen, and perform one set of functions, while another set dies in it and performs another set of functions, we might distinguish them by habit, if not by appearance.

So able an observer as M. Pasteur is scarcely likely to be in error, when he tells us that he has discovered organisms of this kind that live and multiply without oxygen, and others that live and multiply in connection with it; but when he states that the objects arranged by Ehrenberg as six species* of vibrions, are all ferments of putrefaction, and perish in contact with pure oxygen, we may, without in the least impugning the value of his researches, doubt if he could tell by microscopic examination whether certain vibrio bodies belonged to the race of dwellers in oxygen, or to those whom it kills. These doubts are strengthened by a paper recently read before the French Academy by M. J. Lémaire, who disputes many of M. Pasteur's propositions, and recounts the following experiments:—He saturated many infusions that were rich in vibrions with carbonic acid, and then sealed up the tubes containing them. At the end of forty-eight hours most of the "animals," as he carelessly calls them, were motionless, and on the sixth day all were dead. He adds, "M. Pasteur states that the bacteriums absorb oxygen, and that vibrions live in carbonic acid. I do not accept this theory, relying on the experiments cited, and considering the *bacterium termo* and the *vibrio lineola* to be the same animal in a different degree of development." "How," he asks, "can we believe that the animal that is a bacterium in the morning, and a vibrion some hours later, can live under conditions so different?"

M. Lémaire exhibited to the Academy several closed vessels containing a little air and putrescible matters, and from the

* In the March number, p. 239, for "Ehrenberg constituted *six genera* of vibrions," read *six species*.

state of their contents after they had been kept for some time in a warm place, he concluded that "putrefaction commences in a closed vessel by help of the oxygen it contains; this gas permits bacterium, vibrio, and spirillum to grow and live for a certain time, but when the oxygen is consumed they die, and putrefaction is arrested." On reference to the September number (1863) of the INTELLECTUAL OBSERVER, p. 101, it will be seen that M. Pasteur stated that when putrefaction occurred in closed vessels *monas crepusculum* and *bacterium termo* first appeared and exhausted the oxygen, and then, if the liquid contained no fecund germ of the vibrion ferments, it remained without change. This he said was rare, but he had met with several examples. Most frequently, however, in his experiments the vibrions appeared and the putrefaction proceeded.

M. Lémaire disputes M. Pasteur's assertion that there exists special ferments that assist each kind of fermentation; and he states that in his own experiments *bacterium, vibrio, spirillum,* and *monas* transformed a saccharine solution into alcohol, and then into vinegar. In the fermentation of wheat flour he observed, in the course of fifteen days, *bacterium, vibrio, spirillum, amœba, monas,* and *paramecium,* after which came what he calls *microphytes*—a term which most observers would consider ought to include the so-called vibrion family, or most of its members. He distinguishes two epochs in putrid fermentations. During the fœtid stage he observed thirty species of microzoaries. The clearing stage, he states, is announced, when the operation is carried on in the light, by the appearance of the green matter, after which the infusoria that existed in the fœtid stage gradually disappear, and are replaced by *euglena, vorticella,* and *protococcus.* In this case he considers the putrefaction is chiefly due to the oxygen evolved by the green matter.

In the case of neutral liquids, animal or vegetable, he affirms that microzoaries begin the decomposition, and when the liquids become acid, microphytes appear, and the animalcules grow motionless. In the melon, in which saccharine and nitrogenous matter is associated with a small portion of acid, animalcules and moulds appear simultaneously, while in substances decidedly acid he believes microphytes begin the decomposition, and "when the acids are transformed, so as no longer to hurt the microzoaries, these little animals appear, and with them other chemical phenomena." The appearance of species belonging to the animal or vegetable kingdom he considers subordinated to the chemical composition of the substance.

The influence of acids he finds so great in determining the order of the appearance of ferments, that he can by feebly

acidulating neutral substances with acetic, lactic, oxalic, or tartaric acid cause microphytes to take the place of microzoaries, and by the converse process of diluting the acids with water, substitute the microzoaries for the microphytes.

The bearing of the preceding observations upon sundry questions propounded in my paper on the vinegar plant will be obvious, but it is a pity M. Lémaire has introduced so much confusion by a very loose employment of the terms microzoaries and microphytes. Many of his "animals" possess no animal characteristics whatever, and many of his microphytes may be merely some of the so-called "animals" in another stage of development. In the vinegar plant the bacterium bodies which, according to his nomenclature, would be "animals," live and thrive in any acid fluid.

In further discordance with M. Pasteur, Mr. Lémaire believes that, in the process of vinegar manufacture, a direct oxydation occurs as well as that exerted by the ferment, and that the *mycoderma vini* is able to transform alcohol into acetic acid. He remarks that, "in watching the fermentation from its commencement in the must of wine, in vinegar, and in the decomposition of vinegar he has proved the presence of the same mycoderms operating in all these transformations. Upon this, it may be remarked, that the oxydation by which alcohol is transformed into acetic acid, and the further oxydation by which that acid may be again transformed into water and carbonic acid, are processes of the same kind, and naturally produced by the same ferment, and we should get no vinegar at all except for the fact that, while the vinegar plant has plenty of sugar to act upon, it does not destroy the vinegar it has already made. If, however, the yeast plant and the vinegar plant be specifically the same, the condition of the plant must differ, or we could not depend on obtaining alcohol by putting yeast-cells into a saccharine solution, and be equally sure of getting vinegar if the vinegar plant was immersed in another solution of precisely the same kind.

M. Lémaire considers that his remarks throw light upon certain diseases in which microphytes appear on the skin—a state of things he ascribes to the acidity of the secretions; but he does not tell us whether he has ascertained that the secretions are more acid in such disorders than in others in which no microphytes are seen.

It is often a subject of regret in reading French scientific works that our distinguished neighbours do not pay enough attention to what other folks do. M.M. Pasteur and Lémaire would both have arrived at more definite results if they had taken into their consideration the researches of Cohn, Burnett, Arlidge, and others, into the history of organisms, to which

they attribute animal and vegetable characteristics upon insufficient grounds, and the connection of which with other forms of life they do not seem to appreciate.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page 222, vol. iv.*)

499. A comet appeared previous to the second invasion of Illyria by the Bulgarians.—(Zonaras, *Annal.* ii. 56. Ed. Paris. 1686.)

501. On February 13 a great comet appeared in the horizon. On March 2nd it was still visible.—(Ma-tuoan-lin.)

504. A great and brilliant star with a long ray appeared about the time of the death of Ambrosius Aurelius.—(Galfredus, *Britann.* viii. 4.)

507. On August 15th a comet was seen in the N.E.—(Gaubil.)

519. A "fearful star," with a tail turned towards the W., was seen this year, possibly in the winter.—(Theophanes, p. 143; Malala, *Hist. Chron.* xvii.)

520. On October 7th a comet was seen in the E., bright, like fire. On November 30th it was seen in the morning.—(Gaubil.)

524. A star was seen for twenty-six days and nights "above the gate of the palace."—(Cedrenus, *Compend. Hist.* p. 365. Paris. 1647.)

530 or 531. A great comet was observed in Europe and China, but accounts differ as to the year, though probably it was 531. "It was a very large and very fearful comet," and was seen in the W. for three weeks. Its rays extended to the zenith.—(Theophanes, p. 154; Malala, xviii.) It was observed [? passed] in October from α Boötis to λ and μ Ursæ Majoris. —(De Mailla, v. 299.) Hind thinks that this was *Halley's Comet*. If it arrived in perihelion at the beginning of November, it would have occupied the positions given by the historians, and anyhow it must have been near perihelion at this time. It is not impossible that there was a comet in each of the above years, a theory which might perhaps remove some of the discrepancies which exist, supposing there only to have been one comet.

534. A comet appeared in Leo and Virgo; passing ν

and ξ Ursæ Majoris, it moved to the square of Pegasus.—(Gaubil.)

556. In November a comet, in the form of a lance, extended from E. to W., or from N. to W.—(Malala, xviii.) Some writers date this for 555.

560. On October 9 a comet with a tail 4° long, pointing towards the S.W., was seen.—(Gaubil.)

563. A comet, like unto a sword, was seen for a whole *year* (? month).—(Greg. of Tours, *Hist. France,* iv.)

565 [i.] In April—May a comet appeared.—(Ma-tuoan-lin.)

568 [i.] On July 20 a very brilliant comet was seen in Gemini. It moved towards the E. and stopped eight "feet" [or degrees ?] north of θ Cancri on August 18, and then disappeared.—(Ma-tuoan-lin.)

575. On April 27 a comet was seen near Arcturus (α Boötis).

581. On January 20, a comet appeared in the S.W.—(Ma-tuoan-lin.)

582. "In the month of January many prodigies were seen. A comet appeared situate, as it were, in a sort of opening; it shone in the midst of the darkness, sparkled and spread out its tail. From the comet a ray of surprising magnitude emanated, and which appeared like the smoke of a conflagration as viewed at a distance. The comet was visible in the W. from the first hour of the night."—(Idatius, *Episcop. Chron.* vi. 14.)

584. A comet, like a column of fire suspended in the air, was observed, and a great star appeared above it.—(*Chron. Turonense.*)

588. On November 22 a comet appeared near β Capricorni.—(Ma-tuoan-lin.)

591. A comet appeared for one month.—(Bonfin, *Res. Hungar,* I., viii.)

595. On January 9 a comet was visible near β Aquarii. It moved by α Aquarii, ϵ Pegasi, towards α Andromedæ and α Arietis.—(Ma-tuoan-lin; Simocat. *Hist.* vii.)

602. A comet like unto a sword was seen in this year.—(Theophan. p. 240.)

About 605 [i.] In April or May a comet was seen.—(Paul Diacon, *De Gest. Longobard,* iv. 33.)

About 605 [ii.] In November or December a comet was seen.—(Paul Diacon, iv. 34.)

607 [i.] On March 13 a comet was seen in the sidereal division commencing at μ Geminorum, and near υ and ϕ Ursæ Majoris; it passed by κ, τ, θ, etc., Persei, Auriga, α and β Geminorum, the vicinity of β Leonis, and α Herculis, and stopped after fourteen weeks.—(Ma-tuoan-lin.) Probably for Ti-tso (α Herculis), we should read, as Hind suggests, On-ti-

tso (β Leonis), and if we suppose the "ι and ϕ Ursæ Majoris" to allude to the place to which the tail extended, this otherwise inconceivable route will appear more reasonable.

On April 4 a great star appeared in the W. It traversed the girdle of Andromeda, and passing by α Arietis came to Virgo. —(Gaubil.) The Chinese account refers this to another comet, but Hind thinks "it is more than probable that in the description of these so-called *first* and *second* comets of this year, there is some confusion as regards the order in which a *single* comet may have passed through these sidereal divisions and constellations; or observations of the direction of the tail may be mixed up (as occasionally happens) with the positions of the head."

607 [ii.] On October 21st a comet appeared in "the southern region," was seen in Virgo, and passing in the vicinity of β Leonis came to α Herculis; it approached near many constellations, but did not reach the cross of Orion or Gemini.—(Ma-tuoan-lin, who declares this comet to be identical with that of the 4th of April.) For α Herculis, Pingré reads β Leonis, as above, and thinks the European comet or comets of 605 the same as the Chinese comet or comets of 607.

608. A comet emerged this year from α and β Aurigæ, and passing υ, ϕ, etc., Ursæ Majoris, came to β and δ Scorpii.—(Ma-tuoan-lin.) This is precisely the path which *Halley's Comet* follows when its P. P. occurs in October, and as that comet was due about this year, Hind thinks this was it.

614. A comet appeared for one month during the occupation of Jerusalem by Cosroës, King of Persia.—(Lubienitzki, etc.) Date very uncertain.

615. In July a comet was seen to the S.E. of υ and ϕ Ursæ Majoris. It was from 50° to 60° long, and its extremity had an undulating motion. It moved to the N.W. for some days, and when it had nearly reached the circle of perpetual apparition it retrograded and then disappeared.—(Ma-tuoan-lin.)

617 [i.] In July a comet with a tail 3° or 4° long was seen near β Leonis; after some days it disappeared.—(Ma-tuoan-lin.)

617 [ii.] In October a comet appeared near α and β Pegasi. —(Ma-tuoan-lin.) It was seen close to the tail of the Lion, and disappeared after some days.—(Gaubil.)

626. In March an extremely brilliant star was seen in the W. after sunset.—(*Chron. Pasch.*) On March 26 it was situated between the sidereal divisions of the Pleiades and Musca. On March 30 it was near ν Persei.—(Gaubil.)

632. In May or June, or a little later, a sign appeared for four weeks in the S. It was called a "beam," and extended from S. to N.—(Cedrenus, p. 425.)

633. A comet in the form of a sword was seen.—(Weber, *Discursus Curiosi*, etc.)

634. On September 22 a comet appeared near β Aquarii and α Equulei, and α Aquarii and ϵ, θ Pegasi; it passed through Aquarius, and disappeared on October 3.—(Gaubil.)

639. On April 30 a comet was seen between the Hyades and Pleiades.—(Ma-tuoan-lin.)

641. On July 22 a comet was seen in the region near β Leonis; it approached Coma Berenicis, and disappeared on August 26.—(Ma-tuoan-lin.) De Mailla dates this comet a month earlier, and Gaubil says it was in the β Leonis region on August 1.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Nov.* 4.

On some Ichthyolites from New South Wales.—Sir P. de M. Grey Egerton exhibited some specimens and photographs of Ichthyolites from New South Wales; these enabled him to distinguish four genera, two of which are new, and allied to *Acrolepis* and *Platysomus* respectively; the known genera being *Urosthenus*, Dana, and *Palæoniscus*, Agass. Sir Philip was of opinion that these genera were sufficient to stamp the deposit in which they occur—namely, the Coal formation of New South Wales—as belonging to the Palæozoic period, if they may be regarded as representative genera living at the same period as, but geographically distant from, their nearest allies; but, as regards the actual age of the formation, the allied genera are more abundantly represented in the Magnesian Limestone and the Kupferschiefer than in the Coal measures.

On the Geology of the Nile Valley north of the Second Cataract, in Nubia.—Dr. A. Leith Adams' paper on the Geology of the Nile Valley described the physical features of the district, beginning at Selsileh and proceeding southwards, and then the lithological and stratigraphical characters of the Nile sandstone, as well as its mode of junction with the granite, noticing also the evidences of the Nile having shifted its bed, and of other physical changes occurring in Nubia. Near the Second Cataract were abundant proofs of the river having formerly flowed at higher levels, the author having found river shells, such as *Cyrena fluminalis*, *Paludina bulimoides*, *Iridina Nilotica*, and *Œtheria semi-lunata* (the Nile Oyster), as also *Bulimus pullus* and a *Unio* like *U. pictorum*, in beds of alluvium on elevated plateaus at various heights, ranging up to 130 feet, above the highest inundations of the present day.

Dr. Adams concluded from these facts that the Nile was formerly a more rapid river than it is now, and that the force and wearing power of the stream has been steadily declining since the upheaval of the valley ceased.

Dr. Falconer also described two molars in a fragment of the left maxillary of a very large Hippopotamus; the specimen was dug up near the old Temple of Kalâbshe, in Nubia; and belonged to the same species as the existing Hippopotamus of that country.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 9.

Discovery of Snowy Mountain Peaks in Tropical Africa, by Baron von Decken.—A paper was read from the Baron von Decken, in which he mentioned that, on leaving Mombas, he proceeded southward along the coast to Wanga, and thence struck westward up the river of that name. On reaching the Ugono range, 5000 feet high, he found himself among a well-formed race, sufficiently civilized to smelt iron, very rudely, certainly, but with sufficient success to enable them to make no contemptible weapons. He experienced much opposition from the natives, who had got a notion that the mere presence of a European would prove fatal to their cattle. On leaving the Wa-Ugono, or people of Ugono, he coasted Lake Jipé on the west side, and, on reaching the northern end, discovered that the river Daffeta, after entering it from the elevated tract beyond, left it within a mile or two of its entrance. The next point was the Aruscha range, about 4000 feet high, beyond which, at a considerable distance, was another lofty range, probably the eastern watershed of Lake Victoria Nyanza. From this point there was a fine view of the two snowy peaks of Kilima-ndjaro. On ascending the mountain, accompanied by Dr. Kärsten, an accomplished astronomical observer, he encamped the first night at 6000 feet, the next at 11,000, in heavy rain, and saw snow at an elevation of about 13,000 feet. This disappeared by about 9 A.M., but left a clearly defined limit of what seemed to be perpetual snow at about 17,000 feet, the triangulations having previously given the main peak an elevation of 20,065 feet, and the other upwards of 17,000. Still advancing upwards, he attained a height of 13,900 feet, when his companions having given way, owing to the increasing rarefaction of the atmosphere, he was compelled to retrace his steps. He then returned through the Djagga country to the coast. One of the most interesting features of Baron von Decken's paper was a detailed account of a fly, called by the natives "Donderobo," whose bite, as deadly as that of the better known Tsetse, described by Livingstone, was fatal to asses and dogs only; involving serious inconvenience and even danger to the expedition, by the destruction of the draught asses of the caravan. The effect of the poison seemed to be to produce tubercular deposit, following immediately upon acute inflammation.

BRITISH METEOROLOGICAL SOCIETY.—*Nov.* 19.

METEOROLOGICAL DISTURBANCES DURING THE STORM OF OCT. 30, 1863.—At the meeting of the British Meteorological Society, Mr. Glaisher exhibited an elaborate diagram showing the unusual disturbances that occurred during the great storm of October 30, 1863. In the neighbourhood of Greenwich the greatest intensity of the storm was at half-past three in the afternoon, the period when the engine-house at New Cross Railway-station was blown down. At the Observatory at Greenwich it was noticed that the barometer suddenly fell to 28·7, whilst the thermometer as instantaneously rose to 53° Fahrenheit. At the same time the wind, which had suddenly veered round from south to nearly due north, instantly increased in pressure from a very moderate amount to 29½ pounds on every square foot, being a greater degree of pressure than has occurred in this country for thirty years. In describing these phenomena, Mr. Glaisher asserted very strongly on the extreme importance of self-registering instruments, as these registrations could not have been obtained without their aid.

Mr. Glaisher also made some observations on the shooting stars of August 10, and exhibited a model illustrating the mode in which their height above the earth's surface was computed. This is done by observing their angular altitude at different situations simultaneously, and then calculating their height trigonometrically. The large meteor of August 10 last was, when first observed, 130 miles from the earth's surface; it rapidly approached within a distance of fifty miles, and then vanished. The light emitted by these shooting stars was attributed to the friction and compression of the air by the rapid passage of the body through it, the velocity having been computed as amounting to 60 miles per second.

CHEMICAL SOCIETY.—*Nov.* 19.

VANADIUM IN ENGLISH PIG IRON.—Mr. Riley read a paper on the detection of the rare metal, vanadium, in English pig iron. Vanadium was originally discovered in the iron produced at Jaberg, in Sweden, and subsequently in the form of vanadiate of lead at Zimapan, Mexico. It has more recently been detected in a variety of iron ochre, and in the French mineral, Bauxite, now so largely employed as the source of aluminium.

Vanadium has an important practical application in the preparation of an improved form of writing ink. Ink of the very finest and most intense black may be prepared by adding a very minute portion of vanadic acid or vanadiate of ammonia to a solution of nutgalls. This ink is indelible by the ordinary agents that destroy the colour of the iron ink in common use, and it resists a very high temperature. Hence it has been suggested as peculiarly adapted for special purposes, and therefore a new source of vanadium is consequently a matter of considerable practical as well as scientific importance.

A paper was read by Dr. Frankland and Mr. Baldwin Duppa on the formation of compounds of the organic radicles, Ethyle, Methyle, and Amyle with the metal Mercury.

Methide of mercury is formed when an amalgam of sodium and iodide of methyle are allowed to re-act upon each other, the chemical action being established by the addition of a small quantity of acetic ether, which appears to remain unchanged during the process. This compound is a direct combination of the metal Mercury with the organic radicle, Methyle C_2 H_3. In appearance it resembles water, but is remarkable for its great specific gravity, being rather more than three times the weight of that liquid; consequently flint glass containing a large proportion of lead floats on its surface.

NOTES AND MEMORANDA.

Brain of a Bushwoman and Brains of Idiots.—Mr. John Marshall, F.R.S., Surgeon to University College Hospital, has a paper in the *Proceedings of the Royal Society* on the above subjects. The Bushwoman was aged, and about five feet high—unusual for her race. Her cranium is a long narrow ovoid, less dolichocephalic than that of the negro. The frontal sinuses absent, and cranial walls very thick. The cranial capacity is 60·64 cubic inches, equal to 35 oz. av. of water, which, for her height, is decidedly, but not very small. The probable weight of the recent brain is 31·5 oz., or 8·5 oz. less than the average of Europeans of same age. The ratio of cerebrum to cerebellum is usual 7·7 to 1; and that of cerebrum to body probably as 1 to 52; of cerebellum to body as 1 to 418, instead of the usual ratios of 1 to 41, and 1 to 328. Cerebrum defective in width and especially in height, fissures more complex than in Hottentot Venus, but much less so than in the European; they are rather more complex on left than right side of brain, and widely separated from those of the ape's brain. All the convolutions proper to man were present, but much more simple and less marked with secondary sulci. Mr. Marshal remarks that there is a greater difference between the Bushwoman's cerebrum and the highest ape's cerebrum, than between it and the European cerebrum; but a less specific difference between it and the European than between the chimpanzee and the ourang outang. There is, however, less difference between the Bushwoman and the highest ape than between the latter and the lowest quadrumanous animal.

Of the idiots' brains, one was that of a woman aged forty-two, the other of a boy of twelve. The former could walk, though badly, nurse a doll, and say a few words; the latter could neither walk, handle anything, nor articulate a word; the idiot woman's cerebrum weighed 7·6 oz., the cerebellum 1·95 oz.; the pons with medulla oblongata 42 oz. The boy's cerebrum 5·85 oz., cerebellum 2·25 oz., pons, etc., 4 oz. "These are the two smallest brains, the weights of which have been recorded. At first sight the woman's brain resembled that of a chimpanzee: but close comparison shows great differences. The cerebellum especially is of very great size, forming about one-fourth of the entire mass, and instead of being covered by the cerebrum has about ·35 inch of it exposed posteriorly." Mr. Marshal says that "these idiot cerebra have fewer parts and less complex than those of normal brains, and he considers their peculiarities due to arrest of development at some period of fœtal existence. The convolutions in the idiot's brains are more simple than those of the higher apes, and approach, in this respect, those of the lower quadrumana. But the points of difference between the idiot's brains and those of the quadrumana are very decided. They are human cerebra, although so imperfectly developed."

Subdivided Lightning.—At a recent meeting of the *Société Helvétique des Sciences Naturelles*, Professor Dufour mentioned the curious fact, that in last

June the lightning fell on a vineyard at Clarens, and struck 150 trees, having split into so many branches.

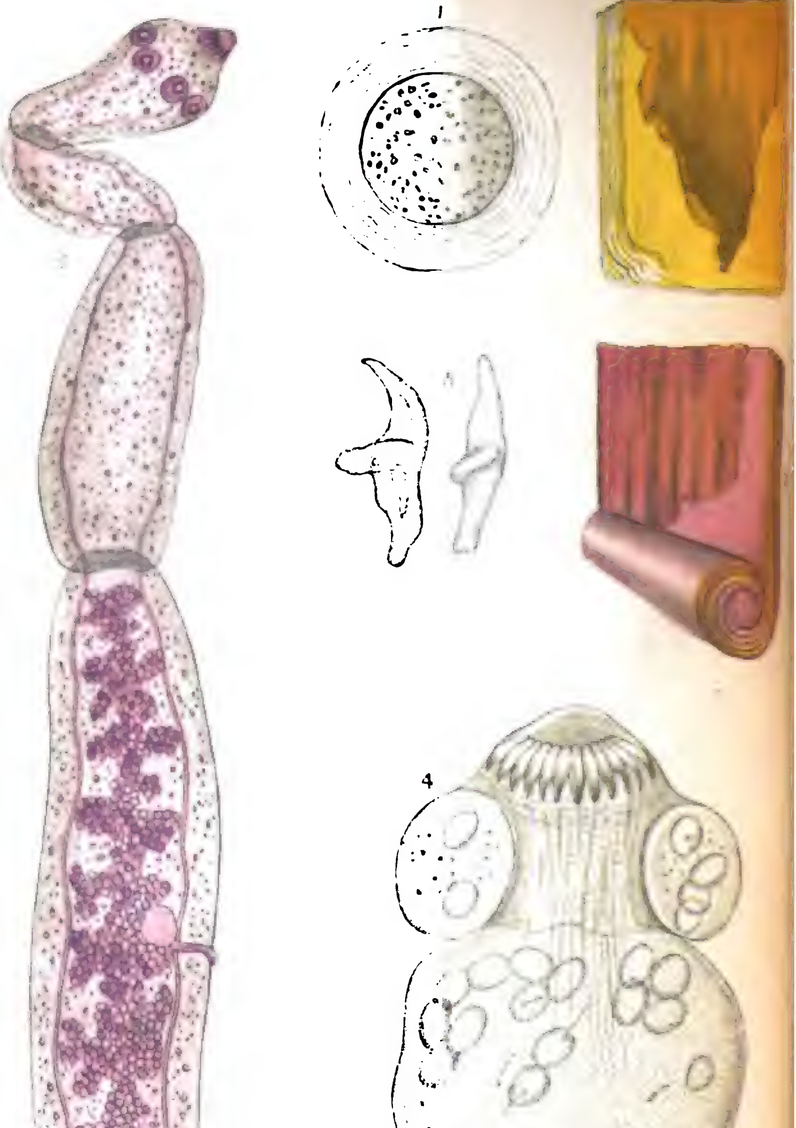
HERMAPHRODITE BEES.—At the same meeting, Professor von Siebold stated that M. Engster, of Constance, had a hive of bees, now four years old, which constantly produced a number of hermaphrodites, which the working bees turned out by hundreds soon after they were born. These hermaphrodites did not resemble each other; sometimes one side was male and the other female; sometimes the head, antennæ, eyes, etc., belonged to one sex, while the posterior portions belonged to another. At other times, the exterior characteristics alternated in rings, and even in half rings. The internal organs exhibited equal diversity. In some cases the hermaphrodites had the sting of the working bees, in others the male organ of the drones, and there were instances of both united. Moreover, the external and internal characteristics frequently failed to correspond, one belonging to one sex and the other to another. Some individuals had the internal arrangement of males on one side on the right and of females on the left, but their exterior was arranged in an opposite manner. One characteristic was constant, that the ovaries were formed like those of the workers, and contained no eggs; while the testicles were completely developed, and exhibited zoosperms. The professor observed that the sex of bees depended on fecundation, eggs into which zoosperms entered becoming females (queens or workers), while unfecundated eggs become males. The eggs from which the hermaphrodites came were laid in workers' cells, and consequently were intended to produce working bees; but they were incompletely fecundated, and thus the development of female organs did not pass beyond a rudimentary state.

CHANGE OF HABIT IN SPECIES.—Professor Strobel observed, at the meeting just named, that he had found in the Po a macrurous crustacean, which he considered to be the *Palæno lacustris* of Lake Garda, affording an illustration of a marine species gradually habituated to fresh water.

DR. WALLICH ON THE AMŒBÆ.—Continuing his important researches, Dr. Wallich arrives at the conclusion that the circulation in the amœbæ is a mechanical effect consequent on the contractility of the sarcode, and not a vital act, "the particles simply flow along with the advancing rush of protoplasm. There is no return stream, but the semblance of one is engendered by one layer of particles remaining at rest while another is moving past them." Dr. Wallich instances additional reasons for considering the various forms of amœbæ as one species, and for confirming the opinion he formerly expressed, that the appearance of a membranous ectosarc betokens encystation. This change he thinks occurs when the reciprocal interchange between endosarc and ectosarc ceases from diminished vitality. (See INTELLECTUAL OBSERVER, xviii., p. 434.) Further information will be found in the *Annals of Natural History*, vol. xii. No. 71.

COMET V., 1863.—M. Tempel discovered this body at Marseilles on the 4th of November, AR = 173° 15′ 8D = 10°. It had the brightness of a 4 magnitude star, and a tail more than one degree long. On the 1st of November, M. Tempel found its daily movement to be + 1½° + 1½°, the same in right ascension as in declination. On the 9th, Dr. Bruhns saw it at Leipzig, and reported to *Astron. Nachricten*, "the nucleus is very bright, and was readily visible, even in the neighbourhood of Venus, with the naked eye. Of the tail we saw little; in the comet finder it appeared to be one degree long."

VIPERS OF FRANCE.—M. Soubeyran describes three species of these venomous reptiles as belonging to France and Central Europe, *V. aspis*, *pelias*, and *ammodytes*. The last has a triangular head, separated from the body by a narrow neck and a prolonged muzzle. He remarks that the characters of the two other vipers vary very much with the locality, the nature of the soil, and even with the season, thus giving rise to numerous sub-species. *Cosmos* affirms that viper-hunters may find abundance in the forest of Fontainbleau, between "les Monts des Fays and la Mare aux Evées," a mile or two from the station of Bois-le-Roi.



Tænia echinoc

THE INTELLECTUAL OBSERVER.

JANUARY, 1864.

RECENT DISCOVERIES IN ENTOZOOLOGY.

(*With a Coloured Plate.*)

It cannot have escaped the attention of any well-informed reader that the subject of Entozoa, or internal parasites, is daily assuming greater importance; and this, of course, not so much on account of the very curious natural history phenomena which these singular animals exhibit, as on account of the strange part they play in the production of suffering and disease, alike as regards ourselves and the animal creation in general. In the pages of the INTELLECTUAL OBSERVER, one of our contributors (Dr. Cobbold) has supplied us with many interesting facts respecting certain parasitic forms which infest birds, beasts, and fishes; but he has not, at present, said much about the entozoa, whose special prerogative it is to take up their abode in the human body. We have, however, lying before us an important work bearing on this subject, as well as a small brochure, by an author whose name is probably known to some of our readers.* In the larger work, which is as yet incomplete, the author enters very minutely into the structure, mode of reproduction, and general economy of the human parasites, dwelling more particularly on those species which produce fatal results.

Instructive as it might be, it is scarcely necessary to take into consideration the various steps by which the earlier entozoological observers arrived at the conviction that the little watery cysts, or *hydatids*, found in man were in reality animals; but we cannot allow the present opportunity to pass without rendering a tribute of homage to those recent investigators and discoverers in this department of science, who have, frequently at considerable risk to their own personal comfort, demonstrated the true source and nature of these lowly organized beings. To Dr. Kuchenmeister, above all others, this recognition is due, and it redounds greatly to the credit of Leuckart (who, at the present hour, is legitimately placed at the head of continental helminthologists), that he has, in the writings quoted

* "Die menschlichen Parasiten und die von ihnen herrührenden Krankheiten." Von Rudolf Leuckart. Erster Band. Liepsig, 1863.
"Die neuesten Entdeckungen uber menschliche Eingeweidewürmer und deren Bedentung für die Gesundheitspflege." Convers. Jahrb. 1863.

below, done full justice to the physician (formerly) of Zittau. Thus, in speaking of the small cysticerci, or measles of pigs, whence we obtain one kind of tapeworm, he says :—

"Kuchenmeister hit upon the idea of administering the measles as provender to other animals, and of studying the changes which took place in the alimentary canal of the quadrupeds thus fed. Such a trial might very naturally suggest itself to any one, but this does not lessen the merit which belongs to Kuchenmeister, seeing that the result was thoroughly decisive. During the passage of the 'measles' through the stomach, they lost their caudal vesicle, which part had previously so strikingly distinguished them, the thin walls succumbing to the influence of the digestive fluids; only when the quadrupeds were proper hosts did the cephalic ends of the cysticerci resist the action of digestion. In this case they passed on, together with the contents of the stomach, into the intestines, in order to anchor themselves here by means of their sucking appendages, and also to stretch and grow into the adult tapeworm condition (Jahrb. s. 629)."

Besides these experiments on animals, it is well known that Kuchenmeister was permitted to feed two condemned criminals, to one of whom he administered seventy-five measles of pigs three days before his execution, the other having eaten twenty measles on two separate occasions, at considerable intervals. In the first case ten very young tapeworms, only a few lines in length, were found after death, and in the second experiment nineteen were found, eleven of which had advanced to the condition of maturity. Subsequently, several young men, we are told, voluntarily came forward in the interests of science, and swallowed fresh measles, and three or four months afterwards showed unmistakeable signs of suffering from tapeworm. They were, we presume, deprived of their internal guests by the employment of the ordinary remedies, when, at least, they had satisfied themselves that they had played the part of host long enough.

But it is neither the measles of pork producing the *Tænia solium* of man, nor the measle-like cysticerci of calves and oxen, producing the *Tænia mediocanellata* (equally common amongst our veal and beef-loving community); nor, again, the *Oxyuris*, vexing children; nor the *Trichinæ* of sausages and hams, and the closely allied species of *Ascarides* (which we probably obtain by drinking unfiltered water); it is not, we say, any of these forms about which we need particularly trouble ourselves just now, but it is in reference to that most fatal of all disease-producing parasites, the so-called *Echinococcus*, to which we now most especially desire to call attention.

Veterinarians, sheep-breeders, stockmasters, and others

practically acquainted with the diseases of our domesticated animals, are at length exerting themselves to ascertain the best methods by which their flocks and herds may be rendered secure from the invasion of certain of the above-mentioned entozoa; but few, if any, of their number are probably aware how much more disastrous to human life are the larvæ of a small tapeworm which lives in the intestines of the dog. In those countries where this animal is well nigh indispensable to human life, it is at one and the same time both a curse and a blessing. The tapeworm (*Tœnia echinococcus*) of the dog produces a larva which annually destroys its hundreds and its thousands of the human race; and sad is it to reflect that the disease thus produced is too often, through sheer ignorance, multiplied and propagated by those who pretend to be able to cure the disease. In happy England fatal cases are of constant occurrence, but it is in Iceland that this disease assumes a formidable endemic character. According to Leuckart and Dr. Krabbe (a pupil of the recently deceased savan, Eschricht, of Copenhagen), who has specially visited the country to investigate the disease, the following facts may be relied on:—

"For every 100 inhabitants of Iceland there are 1100 head of horned cattle, and every peasant has on an average six dogs. In Denmark there are 180 cattle to every 100 of the people. There are many of the Iceland doctors who, not unfrequently, have upwards of 100 patients afflicted with the Echinococcus disease under treatment at the same time, the total number of such cases in the island being estimated at 10,000. By far the greater number of these patients, however, are in the hands of quacks, whose influence is the greater, because there are in all Iceland but *six legally authorized medical men*, each of whom presides over a district of about 1500 square (English) miles, embracing a population of about 10,000 individuals. The treatment of the quacks is exactly suited to keep up the epidemic, for, *amongst their remedies, dog's urine and fresh dog-excrement* play a conspicuous part. (Jahrb. s. 654.)"

These statistics are truly appalling! We have here a forcible illustration of the falsity of the proverb, which says, "Where ignorance is bliss, it were folly to be wise." Would it be folly to get up a Social Science Congress at Reikjavik, and, in the name of humanity and intelligence, appeal to the Icelandic parliament to put down these evil practices with the strong arm; at the same time taking every opportunity to enlighten this grossly ignorant population? Superficial, good-natured *unintellectual observers* may look on complacently, and even, perhaps, remark that the Echinococcus epidemic is one of those mysterious dispensations of Providence which we ought to accept submissively, without looking too minutely into the

secondary causes concerned in its production. For our part, however, we prefer to read His guidings differently, to sound the aforesaid causes to their lowest depths, to search out the animal parasite which thus afflicts mankind, to subject the little beast to microscopic examination, to watch its growth and development, to work out its anatomy, to study its haunts and habits, to make it the source of a series of experiments; in short, to leave no stone unturned by which we may arrive at a sound conclusion as to the best methods of checking its abundance, and of preventing its destructive assaults upon the welfare of our fellow men. An enlightened public will eventually applaud these efforts; but, as in a crowd, it is only the tallest men who see furthest, so, unfortunately, does it happen that our laborious, self-denying, experimental physiologists gain only the respect of the few; whilst the many, unenlightened, prefer the "old paths," not unfrequently, indeed, placing every obstacle they can in the way of those who silently devote their time and talents to studies which are calculated to benefit us all. If it were necessary to exemplify the truth of these remarks, we should refer to the recent attacks made upon experimental physiologists in reference to the question of vivisection, and other investigations demanding the destruction of the lower animals.

One-sixth of the annual deaths among the population in Iceland are solely owing to the Echinococcus entozoon, and shall we therefore refuse to permit the helminthologist to continue his experimental inquiries on the score of cruelty to animals? As a shrewd writer in the pages of the *Examiner* has recently very justly remarked, we have now arrived at a time when "every abomination has its zealous and thorough-going advocate."

The little entozoon producing the disease referred to has this singular peculiarity about it, namely, that in the adult or mature condition it scarcely attains a length of one-sixth of an inch, whilst in the larval, imperfectly developed, or so called hydatid condition, it may grow to the size of a man's hat. In the adult state it is a minute tapeworm, with four joints, and a single head, armed with four suckers, and a double crown of hooks; whereas, in the larval condition, it presents an aspect not unlike those toy air-balls which children play with. This globular hydatid is furnished with hundreds, nay thousands, of heads, each one of which is capable, under favourable circumstances, of becoming a tapeworm. The adult worm, as we have said, lives in the intestines of the dog, whilst the death-producing larva infests man and herbivorous animals of the domesticated kind.

To render our description more suggestive, we beg to direct

attention to the accompanying plate, for which we are indebted to Dr. Cobbold, who is at the present time engaged in preparing a new work on the entozoa of man and animals. He has also supplied us with the following explanatory references, which supersede the necessity of our entering into a more minute description of the worm. This entozoon will, doubtless, be more fully described in his forthcoming work:—

EXPLANATION OF PLATE.—Fig. 1. Juvenile echinococcus—hydatid, about six weeks old (× 50 diam.). From a specimen reared by Leuckart, and now in Dr. Cobbold's collection. 2. Portion of a large Echinococcus hydatid from a cyst in the human liver. From a specimen in the Museum of the Middlesex Hospital, Dr. Murchison's case. Coloured naturally by the bile. 3. Similar portion of an hydatid, artificially coloured with magenta. Dr. Greenhow's case. Specimen preserved in the same museum. 4. Echinococcus-scolex, or head with the hooks and suckers displayed, from a zebra (× about 500 diam.). After Huxley. 5. Two of the hooks separated; one seen in profile, the other in front. After Huxley. 6. An entire sexually mature *Tænia echinococcus*, shewing the head, rostellum, suckers, and the three succeeding segments, the last of which is the largest, and contains the ova and other reproductive elements (× 30 diam.). From a specimen prepared by Leuckart, and now preserved in Dr. Cobbold's cabinet.

Having said thus much about the entozoon, and the disease it produces, one naturally desires to know what methods are to be adopted in order to quit ourselves of these ugly little customers. In the present state of our science we are not, perhaps, entirely able to bring about the total abolition of this terrible hydatid disease, but, at all events, the suggestions of Drs. Leuckart and Cobbold show us the way in which we may check it to a very noteworthy extent. We shall, therefore, allow these gentlemen to speak for themselves:—

"In order to escape the dangers of infection, the dog must be watched, not only within the house, but whilst he is outside of it. He must not be allowed to visit either slaughter-houses or knackeries, and care must be taken that neither the offals nor hydatids found in such places are accessible to him. In this matter the sanitary inspector has many important duties to perform. The carelessness with which these offals have hitherto been disposed of, or even purposely given to the dog, must no longer be permitted, if the welfare of the digestive organs of mankind are to be considered. What blessed results may follow from these precautions may be readily gathered from the consideration of the fact that, at present, almost the sixth part of all the inhabitants annually dying in Iceland, fall victims to the echinococcus epidemic. It is true, that nowhere

else, probably, are the conditions for the development or, rather, the transportation of the echinococci, so favourable as in that country. The dog being not only of far greater importance to the Icelander than he is to us, is, consequently, much more generally kept. Another circumstance, also, must be held to weigh very heavily, namely, that almost everybody in Iceland keeps his own stock of cattle, and lives, during the long winter nights, with the entire living stock, usually huddled together in a very small space. Moreover, that cleanliness which we know to be one of the most important preservatives against infection, is but too often wanting in those parts." (Jahrb. s. 654.)

In reference to the same subject, Dr. Cobbold, in his paper partly read at the Cambridge meeting of the British Association in 1862, and afterwards more fully communicated to the Zoological Society,* writes as follows:—

"My friend Dr. Leared has ingeniously suggested that every dog should be efficiently physicked at a certain given time, and that all the excreta, tapeworms included, should be buried at a considerable depth in the soil. The experiment should be extended over several seasons. The mature *Tænia* thus destroyed would, it is conceived, cut off the supply of embryos and *Echinococci*, and the endemic might thus be averted. To this suggestion I would add, that in place of burying the excreta, *they should, in all cases, be burnt*. If this latter suggestion be not carried out, it is more than probable that multitudes of the minute embryos will escape destruction, and ultimately find their way into the human body. I have previously urged this preventive measure (in my paper 'on the *Sclerostoma* causing the gape-disease of fowls,' published in the Proceedings of the Linnean Society for 1861), with the view of lessening the prevalence of other entozoa, both of man and animals, and I again invite attention to the importance of observing this rule. *All entozoa which are not preserved for scientific investigation or experiment should be thoroughly destroyed by fire, when practicable, and under no circumstances whatever should they be thrown aside as harmless refuse.* In the case of the *Tænia echinococcus*, the greatest difficulty likely to be experienced lies in the fact of the extreme smallness of this tapeworm. As an additional security, therefore, I would recommend that boiling hot water be occasionally thrown over the floor of all kennels where dogs are kept, for, in this way, not only the escaped tapeworms, but also the little free embryos themselves would be effectually destroyed."

* "Remarks on all the Human Entozoa." By T. Spencer Cobbold, M.D., F.L.S., Lecturer on Compt. Anat. at the Middlesex Hospital.—*Proceed. Zool. Soc.* for 1862; vol. xxx., part iii., pp. 288—315.

A DAY WITH THE FIELD CLUBS.

BY THOMAS WRIGHT, M.A., F.S.A.

PERHAPS many of our readers will hardly know what a Field-Club is, although, during the last few years, this sort of society has become very fashionable in some parts of our island. Natural History Societies have existed long in almost every country town, and they have established museums, and, from time to time, listened to lectures; but the field-club presents a different and a pleasanter method of studying science. Gentlemen, and ladies too, form themselves into a society for the purpose, not of sitting on benches in a close room to listen to a lecture, but of meeting at a pre-appointed locality, and of strolling together during a long summer day over the country around to explore its geology, its botany, its natural history, or its antiquities. Particular districts must, of course, be more congenial than others to associations of this description; and among these favoured districts stand foremost the beautiful counties on the borders of Wales, in which apparently the idea of field-clubs originated, and where they are still more numerous than in other parts of the island. The first of which I have any knowledge was the Woolhope Club, which was established partly by the exertions of the late Rev. T. T. Lewis, and of which his friend Sir Roderick (then Mr.) Murchison was one of the earliest members. Woolhope is a parish in a very picturesque part of Herefordshire, the country around which possesses great interest for the geologist, and hardly less for the botanist; but the original object of this club was to explore the geology of this particular district. Gradually the Woolhope club abandoned geology to a considerable degree and devoted itself to botany, and at one time went so far as to offer prizes to its members for the discovery of plants of unusual rarity. The idea of these clubs next passed the border of this county into that of Worcester; but the Worcester Field-Club assumed more the character of a Natural History Society. At a subsequent period a field-club was established at Malvern, which has met with considerable success, and set the good example of forming a museum for its collections. The taste for these clubs extended from Worcester in two directions—southward into Gloucestershire, where the Cotswold Field-Club rose into existence, a small and rather aristocratic body, and northward to the mineral districts on the Staffordshire border, where quite recently a field-club was formed at Dudley, which is the most numerous society of this class yet

established. In Shropshire these clubs are of very recent date. There is one at Ellesmere, which, like those of Dudley and Malvern, is forming a museum; and another at Oswestry, close upon the Welsh county of Denbigh. Two other Shropshire field-clubs, the Severn Valley Club and the Caradoc Club, which have been formed during the present year, have distinguished themselves by their energy and activity. The former has for its special field the district from which it takes its name and the Wenlock Mountains; the other has its head-quarters at Church Stretton, between the mountain ranges of Caer Caradoc and the Longmynd. Although, however, these clubs belong properly to particular districts, they have adopted the custom of fraternizing occasionally, and holding joint meetings at places of special interest. Thus, on the 7th of July in the present year, the Caradoc, Woolhope, and Oswestry Clubs held a joint meeting at the Craven Arms in Shropshire, and explored together the interesting district of which that place is the centre; and on the 13th of August, the Caradoc and Severn Valley Clubs joined in a meeting at Church Stretton. It was at this latter meeting that I attended.

It was one of the hottest days—perhaps the hottest—of this unusually fervid month of August, when, on the morning of the 13th, I took a forenoon train from Shrewsbury, with a number of companions bent on the same errand. We soon approached the entrance to the beautiful Stretton valley, overlooked by the lofty mass of Caer Caradoc, which, seen in this direction, rises on one side somewhat in the form of a vast sugar-loaf, and stands here like a permanent sentinel on guard over some enchanted region. Caer Caradoc, on this side, appears to most advantage when seen from the railway, a little to the south of the Dorrington station. A few minutes more and our train left us at the Church Stretton station, where we were soon afterwards joined by another body of our associates, who came by the train from the south.

Church Stretton is a picturesque town, seated at the foot of the Longmynd range, which forms the western side of the valley, and nearly opposite Caer Caradoc, which, with the range of mountains out of which it rises, and which are known collectively as the Stretton Hills, forms the limit of the valley to the east. At the bottom runs the ancient Roman road from Uriconium (*Wroxeter*) to Magna (*Kenchester*) and South Wales, now called the Watling Street, and still forming part of the high-road from Shrewsbury to Hereford. Through the valley, which is watered by numerous little trout streams, sparkling in the sunshine as they wind their course through pleasant meadows and copses, this ancient road runs nearly parallel with the railway, and may frequently be seen from it. Geologically this

district is full of interest. Church Stretton itself is situated nearly on a very remarkable line of "fault," which extends all along the base of the Longmynd Hills, and by which the strata, once horizontal, have been so completely disturbed that on one side of this line the ancient Cambrian rocks are now tilted up almost perpendicularly, while on the other the much more recent Wenlock (or, as some suppose, Ludlow) and Caradoc rocks repose against them in a far more horizontal position. This displacement has manifestly been accomplished by the pushing up of the strata to the west of this fault; and the unconformity is considered by Professor Ramsay to amount to two thousand feet. This powerful dislocation was probably connected with the volcanic action of which the Caradoc and its neighbourhood present so many traces. The rocks of the Caradoc have been submitted to far greater heat than has acted upon the Cambrian rocks, which occur much lower in the order of the strata; so intense indeed has been the igneous action that all traces of fossils have disappeared, though the lines of stratification, which identify them with other rocks in which fossils abound, are preserved. Igneous action is, of course, closely connected with volcanic action, and it is a remarkable circumstance that this line of "fault," on the eastern side at least, continues to the present day subject to those shocks of which we have lately had so notable an example. It is even stated that in Ludlow, which is divided by a well-known "fault," the earthquake was felt considerably on one side of the town, while the other part was comparatively exempt from it.

Soon after eleven o'clock the members of the united field-clubs and their friends, who had assembled at Church Stretton, proceeded from the railway station on their way to Caer Caradoc. The mountain presents on the side towards the high road, that is, on its western flank, a declivity so steep that the ascent is almost impossible; but by a lane, which turns out of the road from Church Stretton by way of Hope Bowdler towards Wenlock, and leads up through the elevated valley between Caradoc and Hope Bowdler hills, we reach a spot where, though the ascent is still very difficult, it is somewhat less abrupt, and the distance to the summit is considerably less. A few of the party, who were unwilling to encounter the fatigues of the longer excursion to which the printed programme invited us, separated from the rest soon after leaving Church Stretton, and followed this short and direct road to the mountain; but the greater part chose the way to Hope Bowdler. This road, for nearly a mile, presents a gradual ascent, and we proceeded but slowly both from this circumstance and because the attention of the visitors was continually arrested by the imposing masses of the Caradoc, Lawley, and Hope Bowdler hills before

us, and by the still greater beauty and the continually changing variety of the prospects presented behind us by the Longmynd hills as they backed the town we had left; and some gathering clouds, which threatened a thunderstorm at this moment, added greatly to the beauty of the latter by the bold contrasts of light and shade which were suddenly thrown over them. Passing through the turnpike gate at Hazlar, a little more than a mile from Church Stretton, we soon reached the village of Hope Bowdler, somewhat less than a mile further. Along this road the first objects of interest were occasional quarries of metamorphic rocks—the ancient Caradoc sandstone altered by heat; and at Hope Bowdler we saw a layer of conglomerated pebbles, water-worn, slightly stratified, but not in a horizontal direction, and reposing on the highly-inclined edges of Caradoc strata. Such layers are wonderfully interesting, for it is through a careful study of them that we may hope to trace the history of these primeval rocks and of the marvellous changes which have taken place during and since their upheaval. A single pebble in such a stratum tells a long history in itself. It was once a component part of previously existing rocks, was torn from them by the action of mighty primeval forces, was *rounded* by rolling hither and thither on the shores of ancient seas, and was deposited at last, with other similar pebbles, in the bed in which we now find it resting. During this time the rocks on which we find it thus reposing were subjected to immense heat and pressure, and were afterwards raised from their original horizontal position into one highly inclined; and when we consider the slow progress of such operations as they are effected in the present day, our minds feel confounded at the contemplation of the immense periods the workings of which lie thus displayed before us.

From Hope Bowdler we turned south, by a lane which, at the distance of about half a mile, brought us to the rather extensive quarries of Soudley, interesting for their good display of the lower Silurian fossils, but still more so as being the key-note from which the wide scale of the Silurian system appears to have been struck off. This quarry is worked in the uppermost strata of the Caradoc sandstone, presenting a face of about a hundred feet in thickness, in which beds of good free-stone alternate with layers of sand, and of a softer stone, in which the best fossils are found. Upon this latter stone the visitors employed their hammers very energetically, to the great astonishment of the quarrymen, who were working the stone for very different purposes; and the former soon collected specimens of rare fossils, such as the diplograpsus, the simplest form of the doubly-serrated graptolites, fossils distinctive of the lower Silurian rocks, which do not vary much in

England, but are eccentric enough in the specimens from Canada and Bohemia; while orthis of many species, strophomena expansa of large size, tentaculites, leptœna sericea, and many other shells, were easily found, along with joints of encrinites and fragments of the beautifully-dotted trinucleus Caractaci, a perfect specimen of which is rarely met with. This spot presents the Caradoc strata in their simplest form, unaltered by heat or distortion, and left behind by the vast force of igneous action which has raised the same rocks in an altered slaty condition to the summit of Snowdon, and by which also this picturesque chain of hills which we were now going to visit, and of which Caer Caradoc is the chief, was protruded. The work of geological hammers was suspended for a moment to listen to a popular lecture on these Silurian rocks by the excellent Vicar of Stokesay, the Rev. J. D. La Touche, one of the most active leaders of the field-club movement in Shropshire, and to some further remarks by Mr. Lightbody, the eminent geologist of Ludlow; after which we proceeded to retrace our steps in the direction of Caer Caradoc.

At Hope Bowdler the party had been joined by those members of the Severn Valley Club who had driven across the country in carriages of various descriptions, and it had now become numerous, amounting, as it was said, in all, to about a hundred and eighty, of which a considerable majority consisted of ladies. We may well suppose that such a sudden invasion of the hill districts must have caused no little surprise among its scattered population; and this was displayed in one or two rather amusing incidents. At one place in the road, an old woman and her husband, looking out from their cottage door, expressed their views on the subject loud enough to be very distinctly heard. "Who may they folk be, dun ye think?" asks Darby of his faithful Joan. "Oh!" replies Joan, who was evidently of a literary turn of mind, "why, they be the pilgrims you read of in books, sure enough they be a-going a pilgrimage." In fact, she took us for some of the numerous personages immortalized in the pages of the "Pilgrim's Progress." And one of our fair companions afterwards remarked that we had indeed come to "the Hill Difficulty," and confessed to having found it "very toilsome in the ascent, and somewhat slippery."

Towards this difficult hill the whole party now proceeded, as the special object of this meeting was to study the curious and instructive dislocations of the earth's crust which were there brought to view. On the way, specimens of almost every variety of igneous material were met with among the *débris* rolled down from the sides of the mountains—porphyries, hard and bright-coloured as those of Egypt; red and grey jaspers,

greenstone, white and pink quartz, and many rarer minerals. The mass of the rock is felspathic, like that of Malvern, with tufaceous heaps of half-burnt cinders, and sandstones and conglomerates changed by heat into shattered quartzose and granitic blocks. Attracted by the prospect of a pleasant country lane, and in the expectation of making a short cut to Caer Caradoc, I had turned off from the road with a small party, immediately after repassing Hazlar gate. We enjoyed for some distance the rural character of the road we had thus taken; but we soon found, that instead of easing our walk, we had to pass over the ridge of an intermediate, though not very elevated hill, and our progress was rendered somewhat difficult by the luxuriance of the ferns which covered it. On our way up, Hope Bowdler hill presented a bold mass on our right, stretching out from the south-west to the north-east nearly parallel with Caradoc, and we had a very distinct view of the singular object on its side, which the peasantry call the Battle Stone; and they tell us in their legendary traditions of sanguinary engagements which took place in this valley, and how the prisoners were carried up the hill to be beheaded on this stone—it being then, of course, the custom thus to treat any unfortunate captives. The stone is a porphyritic mass, with red stains, which seem to have suggested to the popular mind these tales of slaughter. The descent of the hill we had to pass was found steeper than the ascent, and it was uncomfortably marshy at the bottom; and we had to cross a marsh and a stream before we stood in the middle of the valley, with the mighty mass of Caer Caradoc before us. This place of meeting had, as it will have been already seen, been fixed entirely on its geological claims, for the district over which we were wandering presented no great interest to the botanist, and not much to the archæologist. The faces of the hills are covered mostly with rather stunted gorse, heather, and wild thyme, sprinkled over with the blue hairbell, and there are few plants of any rarity. The *Drosera rotundifolia*, or sun-dew, is said to be found in these marshy spots at the foots of the hills, though if so, it is very rare; but the *Pinguicula vulgaris*, or butterwort, an exquisitely beautiful purple flower, grows here abundantly.

The Caradoc range is, as already indicated, a mass of extremely abrupt mountains running from S.W. to N.E., highest at its north-eastern end, where Caer Caradoc rises to an elevation, according to the ordnance survey, of full 1200 feet above the level of the sea. The elevation is most considerable from the plain on the west, on which side its summit is almost inaccessible, but on the eastern side it is less elevated, because it rises from an elevated valley; nevertheless, especially on such a sultry day as the 13th of August, it required both courage

and strength to venture up it. The heat of the sun had dried up the scanty grass which covered its surface, and had rendered it so slippery that it was almost impossible to stand upright on the side of the mountain; and it was only after a long struggle, and a combination of springing up and slipping down, with an occasional moment of rest, by taking advantage of some small, stunted bush of gorse, that the visitors, weary and exhausted, reached the summit. Like provident pilgrims, most of them had contrived to carry some amount of refreshments, which they here found exceedingly welcome, as they gazed on the magnificent scene around. The top of Caer Caradoc forms a very uneven area, of no great extent, but surrounded by an ancient double entrenchment; for what purpose it would be in vain to attempt to decide with our present knowledge. Many of our old antiquaries and historians, who had evidently never seen it, set it down very absurdly as the site of the last battle of the British hero, Caractacus; though its position is anything but a convenient one for any kind of military operations. It is more probably a burial-place, for we know how much the primitive peoples loved to inter their dead on the summits of lofty hills; and, at a hasty view, there appeared to be some traces of what may have been sepulchral tumuli. The view from the top is, as we have just stated, grand and varied; and those who, coming direct from Church Stretton, had mounted earlier in the day, had been able to enjoy it with a clear sky; but afterwards, as one of the results of the extreme heat, the distance became more and more concealed in a hazy mist. This was the case especially on the side towards the north-west, where a clear distance was above all things necessary to exhibit in its full beauty the vast panorama presented by the vale of Shrewsbury and the country for an apparently interminable distance beyond. Towards the east, however, we could distinguish tolerably well through the mist the long line of the Wenlock Edge, extending north and south for nearly twenty miles, and appearing over it at intervals a second ridge, called the ridge of Aymestrey limestone. Between them intervenes a valley worn in the soft shale, which lies between the Wenlock and Aymestrey limestone, by the action of those mighty currents which once washed over the whole area on which we stood. Had there been no mist we should have seen in the distance, behind the Wenlock and Aymestrey lines, a third, composed of Old Red Sandstone, and the view would have been bounded in that direction by the two Clee Hills, which are composed of mountain limestone and the coal measures. Towards the west the great mass of the Longmynd presented itself, running parallel with the lines of hills just mentioned; but, as stated before, a long line of "fault" has

brought the Caradoc strata into juxtaposition with the Cambrian; and thus, as the geologist is aware, a vast stratum called the Llandeilo is unrepresented on that side of the Longmynd; it lies, in fact, deep down under Church Stretton. On the other side of the Longmynd, however, it is found largely developed.

In thus looking over the country around we could trace the various layers which compose the Silurian rocks from their base upwards, and the regularity of their succession; the distinctness, indeed, with which it is marked in that neighbourhood is most striking, and leads us to the conviction that, once on a time, piled high above the ground on which we stood, this vast mass of strata, measuring fourteen English miles and a-half deep, stood accumulated; that gradually a great crack (the "fault" before named) occurred; and that in the upheaval the Longmynd side outstripped the other; that over the surface of this area, probably during the whole time it was being gradually raised above the bed of the ocean, the waters rushing to and fro denuded the higher parts of the dome; and that we now trace in the ridges contemplated from the top of Caer Caradoc the materials of the shell which has thus been so curiously formed and laid bare. Ancient Caradoc still bears on his shoulder a sample of the material covering which once lay over him. A very small party descended—and they were obliged to do it in a most undignified position—the almost perpendicular slope of the west side of the Caradoc, to where a huge mass of the Aymestrey rock is found reclining at a very high angle; which, by its great hardness, being detached, has remained there as a witness of the continuity of the stratum which once extended over the whole area. The thrusting up of the Longmynd range has given us the opportunity of examining the various layers, from what is believed to be the first deposit on the earth's original surface, for the lowest of these strata have been regarded by geologists as the earliest deposited rocks, the most ancient part of the outer crust of the earth. The shales of the Longmynd contain the first traces of life, the Arenicolæ, and display the marks of the ripples of primeval tides, and even casts of raindrops, on the thin layers composing the strata.

Before this descent, however, the formal meetings of the two clubs, severally, had been held on the side of the hill-top which looked over the valley eastward, and their routine business had been proceeded with; after which, while the listeners reposed themselves in groups on the sod around, a short lecture on the ancient tumuli of the district was delivered, in fulfilment of a promise, by the writer of the present paper. The small party who had visited the mass of Aymestrey rock on the western flank of the mountain continued their laborious descent

on that side, and returned to Church Stretton by the Roman road, the Watling Street. The rest descended gradually the same side they had gone up, and after a pleasant walk down the valley, reached Church Stretton to partake with the others of a well-furnished cold dinner, after which the rector of Church Stretton, the Rev. H. O. Wilson, threw open to the visitors the beautiful and very extensive and ornamental grounds attached to the rectory, which extend up some of the lower slopes of the Longmynd, and formed a very pleasant spot for meeting and conversation after the labours of the day. To those who had returned by way of the Roman road more objects of antiquity had presented themselves than had been seen in the earlier part of the day, and on one of the slopes of these pleasure-grounds I read to them a paper on the Roman roads in Shropshire. The evening was already advanced when I left for Ludlow, quite convinced that the meeting of a field-club is a very agreeable, as well as a very intellectual and instructive, manner of passing a summer's day.

METAMORPHISM.

BY PROFESSOR ANSTED, M.A., F.R.S.

If the reader be alarmed at a title so technical as the word Metamorphism let him examine the first piece of Portland or Bath stone that comes in his way, or let him go to the nearest quarry or brick-pit and look at the state of the mineral substances there laid bare. Let him further consider that these stones and clays must certainly have once been mere heaps of shelly sand and mud, confused and impalpable, and that to bring them into their present state they have undergone no external change. Operated on no doubt by the great silent forces of nature that are everywhere present, they also bear no marks whatever of any special modification of structure. He will not fail to perceive that great change has been produced, that shells have become altered, the original material being displaced by crystalline carbonate of lime, that nodules have formed in the clays, that each limestone has a structure of its own by which it may be distinguished from other limestones, and in a word he will everywhere see proofs of some curious transforming agency for which a name is desirable. Let him call this agency *metamorphism* and the change a *metamorphosis*, that he may be able conveniently to examine, discuss, and understand the alterations that take place in rocks without affecting their external form.

Should he be able to visit large quarries or observe those

crevices and fissures more or less filled up with foreign ingredients that characterize certain districts, he will find still more striking examples of change in the arrangement of the atoms of various substances quite independent of any change of external form. He will find calcareous shells becoming siliceous, still retaining their minute structure; trunks of trees also silicified, from which he can get slices for the microscope that will exhibit all the details of organization; hollow flints and other stones, with a perfect lining of the most beautiful crystals.

If he visit Wales and Cornwall, and can examine slate quarries and places where such rock as granite is worked, he will find structure so new and peculiar, so complicated and so curious, that he will fancy himself studying the remains of another world; he will then begin to think of molten rock penetrating into and altering the other rocks; he will dream of the deep recesses of the earth where abundant stores of fluid granite are always ready at hand to perform nature's miracles; where all the marvellous phenomena of volcanoes are prepared, and where, in fact, having reached Vulcan's workshop and nature's laboratory, he is at liberty to amuse himself with all the explosive compounds, the great furnaces, the powerful acids, and the overwhelming forces he believes to exist there, and thus settle all the difficulties of geology at one effort. It would be strange if with all these facilities of producing disturbance, our adventurous, but still dreaming student, did not give way to temptation and return from dreamland a confirmed Vulcanist, referring every disputed point to some result of the action of fire on the materials beneath his feet, knowing nothing whatever meanwhile of the condition of the earth's interior, of the mode in which rocks are changed, or of the connection between volcanic phenomena, which are really igneous, and those that have produced granite and modified clays and limestones at great and unknown depths beneath the earth's surface.

The earlier geologists were, in fact, in the position here indicated, and have behaved in a manner not very different from that of our dreaming student, and their dreams have unfortunately been accepted as sound conclusions, occupying a prominent place in most popular works on geology of the present day. There has been a long and hard struggle for many years to found another school of geology to question nature a little more closely as to her style of work in reference to these altered rocks, without these gratuitous assumptions, and to put aside as a matter to be inquired about and not taken for granted, the influence of intense melting heat in the interior of the earth, within those narrow limits that come within human observation, and which alone have been concerned in the work of metamorphosis.

The condition of the earth's interior can never be known by direct investigation. The deepest mine is not nearly three thousand feet below the surface, not a fifth part of the amount of the inequalities either of mountain or ocean. Within that depth there are no doubt indications of a gradual increase of temperature, but it is quite unsafe to assume that this change continues or that it is connected with any uniform increase towards the centre, as it may be purely superficial in every important sense of the word. Volcanoes are phenomena which no doubt indicate that in certain districts and under certain conditions there is a disturbing force at work beneath the earth's surface, and that a high temperature exists at the moderate depths at which volcanic action seems always to originate.

But all this is a very small scintilla of evidence on which to base so important a conclusion as that the interior of the earth is in a state of igneous fluidity. The skin we can examine is a film so thin in proportion to the diameter of the earth that it does not correspond to more than the coat of varnish on a three-foot globe.* It cannot possibly justify any deductions as to the state of the interior, since even the phenomena of volcanic action are local. The only real evidence on the subject is derived from investigations purely physical. Thus by an elaborate calculation, the details of which will be found in the *Philosophical Transactions* for 1857, Mr. Hopkins concluded that the increase of temperature in deep mines cannot be due to any such cause as central heat. Long before this the same mathematician had shown that the earth could not have a fluid nucleus approaching within several hundred miles of the surface, and very lately one of our most distinguished physicists, Professor W. Thomson, of Glasgow, has shown the probability that unless the earth were more rigid than steel to a depth of at least two thousand miles, it could not maintain its figure against the tide-producing forces of the sun and moon so as to allow the phenomena of the ocean tides and of precession and nutation to be as they are.†

Putting aside then for the present the assumption that the earth has once been in a state of fluidity from heat, that it has cooled down gradually until a thin film has formed on the surface, and that this film has since been cracked and the fissures filled from the molten sea of fire below, let us endeavour to seek for some explanation of known phenomena without this hypothesis, and, if possible, without any preconceived notion or theory whatever. Let us consider the state of the earth's outer film, or crust, the changes to which it is subjected, and

* Three thousand feet corresponds to 1-200th of an inch on a three-foot globe.

† *Proceedings of Royal Society* for April 14, 1862.

the relation that these changes seem to bear to laws that we can study, and forces that we can measure.

The work that goes on near the earth's surface takes its origin at the contact of earth, air, and water, and the action of water and weather upon all exposed rocks is constantly tending to grind and pare away inequalities. Thus there is a never-ceasing piling up of mud, and stones, and sand, in the great expanse of the ocean, but especially near the shores, where the waves are always beating, and towards which the rivers bear their tribute. Marine currents spread this over the sea bottom, and with it is mixed a vast, but very variable quantity of organic matter, either bones, teeth, shells, corals, or the microscopic cases of animalcules, according to circumstances and conditions which we can occasionally study, but with which we are not perfectly familiar. The rate of such accumulations over the whole earth must certainly be very large every year, and if there were no counteracting cause, the result would in time reduce the land to the merest shreds and patches of the hardest rock.

But that there is some counteracting cause is certain, for its results are traceable without much difficulty. In many parts of the earth there are movements of elevation or depression—limited, no doubt, at present, to definite areas, and, perhaps, not unconnected with those districts where earthquakes are felt, and where volcanoes cast out from yawning cracks in the earth volumes of steam, fiery floods of lava, and thick clouds of ashes. Very slow are these movements, but, perhaps, not much slower than corresponds with the amount of accumulations at the sea bottom, but the result is that all the great heaps of mud, and sand, and pebbles, and angular stones, mixed up with the remains of animals and vegetables, become buried —carried down bodily away from the surface, and covered up with similar deposits.

Material thus depressed and squeezed, after being deposited in water, becomes exceedingly compact and tenacious, as is known by the state of the mud at the bottom of the Atlantic. Under such circumstances, it parts with some of the water with which it was formed, and it tends to become solid. It then by degrees enters into a region where the temperature is equable. As it goes deeper it is exposed to greater heat, and it is highly probable that the law of increase of temperature in descending into the earth, which is pretty uniform for 2000 feet, continues nearly the same to much greater depths. By degrees, then, the descending mass becomes heated, and at the same time it is constantly under pressure.

That the currents of electricity producing the phenomena of earth-magnetism chiefly act within a certain distance from

the external surface of the earth, that they permeate all matter placed there, and that in so doing they induce chemical action, are among the conclusions which the discoveries of modern science may be said to render certain. Thus the matter originally deposited as mud, and consisting of a heterogeneous assemblage of the minerals most common at the earth's surface, is now placed under the conditions known to be most favourable for enabling all its component parts to exercise their chemical affinities and re-arrange themselves in new forms.

The first result of this is that like things collect together. In a mixture consisting of clay and limestone mud, the limestone or calcareous part collects into bands of nodules at certain distances apart; the sulphur and iron, if present, combine to form pyrites; the excess of iron, if any, is converted into oxide, and combines with the calcareous nodules, forming poor or rich earthy iron ores, according to circumstances; and so on with other elements.

Meanwhile the whole mass, becoming systematically compacted, contracts, and crevices occur—thin, perhaps, and partial at first, but more or less open, and gradually increasing. Crystallization takes place in some of the minerals easily crystallizable, and that curious change takes place called by mineralogists *pseudomorphism*—the removal of some definite form, and the replacement of the original by some new substance. The remains of organic beings, animal and vegetable, become converted into fossils.

Throughout the whole mass, whatever else is going on, and in whatever state it may be, water is constantly circulating. Entering the earth at every pore, passing down through all rocks in all conditions, dissolving everything as it goes, leaving behind in every place something new, and modifying every form of matter, this great power, this really universal menstruum, knows no obstacle, and never ceases to do its work. Carried down at first through open fissures in all rocks, it is further conducted through the open and permeable sands in large quantities, and through rocks of closer texture, by the most minute capillary tubes. The actual quantity of water in all rocks varies from five to forty parts in a thousand, even when they are in the driest state to which they can be reduced by exposure to the air.

And here, again, we are able by actual experiment to understand something of nature's methods in the interior of the earth. It might well be supposed that rocks squeezed under enormous pressure would become more compact and less porous; on the contrary, they become more porous, and it is certain that both the dissolving and penetrating power of water are increased in proportion to the pressure. Thus the

work that goes on very slowly and imperceptibly at first, is more rapid and energetic in proportion as the depth is greater, and the most impracticable and refractory rocks are those which are more thoroughly influenced by the action of water in the interior of the earth.

That water is capable of reaching the separate minerals of crystalline rocks, acting specially on some one of them, removing one member of a group, and replacing minerals by others, without in the smallest degree altering or affecting the external form, is a fact of which there is absolute proof. That water alone is capable of replacing the limestone of a shell by galena and other sulphides of metals, and even by native metals, such as silver or copper, is equally certain. That water alone has dissolved and removed, in one case, silica; in another, carbonate of lime; in another, felspar, and probably almost every familiar mineral, placing in the stead of these other minerals, which it can also again remove, is one of those curious and almost inexplicable facts that nothing but absolute and direct proof could make credible; but facts are stubborn things, and must be accepted when they present themselves.

When, then, in crevices of rocks, whether wide or narrow, and whether filled completely or partially, we find groups of strange minerals and metals, quartz, and other crystals, and even granite and porphyry (mixed masses of crystals), we need not at once assume that these have been once in a molten state; we should rather inquire how far they may have been separated out from the mass, or introduced by currents of heated water acting during long periods of time under certain chemical conditions. Some of the appearances it is now certain may have been produced by water; most of them cannot be proved to be brought about by fusion under any known contingencies.

But if this is the case with veins, much more is it the case with the masses of rocks loaded with organic remains still retaining their intimate structure. In them there is often a wide departure from the normal condition of soft mud, sand, pebbles, and animal or vegetable remains; and yet, though so great a change has supervened, there has certainly been no exposure to heat, for none of the results of heat are in any way traceable. Where, as in the case of leaves and wood, heat would convert the whole mass into an ash, the result is the production of a combination of carbon, hydrogen, oxygen, and other gases, capable of serving still as an admirable fuel. It is not necessary to point out what the result would be if heat had been applied to such a combination; but where the case is less manifest, it is often not less certain, and thus abundant proof exists of the possibility of enormous and complete change without any exposure to burning heat. In all cases, however,

there is change, and generally it is of a very marked kind, between the original and present condition of rocks. This change is *metamorphism.*

Let us consider the principal varieties of rocks, one after another, with reference to this point. Sand and pebbles, with occasional thin beds of marl, are the rocks least altered, and often these are hardly changed from their original state. They are neither more compact nor of different texture. Sometimes, however, they are converted into stone, the sand particles being cemented by carbonate of lime, silica, or oxide of iron, all clearly and unmistakably brought in and deposited by water. Sometimes, parts are unchanged and other parts converted into crystalline quartz rock, with no mark of heat. Sometimes, on the marly films are crystals of marl, occupying places once occupied by crystals of salt. The marl has been carried in by water to replace the salt crystals dissolved by water. Scarcely any organic remains are preserved in such material now, and there is not much indication of life in the older example, but footprints of animals, worm casts, etc., prove that life was present. Crevices in the sand rock are filled up with crystalline quartz, certainly of water origin.

Limestones are more varied and richer. Deposited as mud, or coral, or shell sand, the particles are cemented by carbonate of lime. Sometimes the whole mass is compact and crystalline, sometimes parts are crystalline, sometimes the whole is semi-crystalline. The shells are changed; they preserve their form; they sometimes retain parts of their original structure, and sometimes they are full of calc spar; or the shells are gone, and their place is occupied by casts, also of carbonate of lime, or perhaps of iron oxide. The whole mass is uniformly tinted with iron oxide, or the iron is collected into belts, and these are often rich enough to be exceedingly valuable as iron ore. The rich ores recently discovered and now chiefly used in the north of England are of this kind. Any foreign substances once mixed up with the limestone mud are now collected and separated in veins or crevices. Large cavities and empty spaces are common in the mass, and these are filled partly with broken fragments of the same limestone, partly with valuable ores of lead and zinc. The whole series of operations, thus changing the limestone mud into important limestone rocks, with mineral veins, is the work of currents of water. Water has compacted the loose particles; water has opened large cavities; water has filled them with quartz and other crystals; and water has carried in the metals. A little heat would have changed the whole mass, and caused fresh combinations. This at least is the case as far as we can judge. It is the case according to experiment, and no one, without conflicting

proof from experiment, is justified in making a contrary assumption.

And the case of clays is not different. Very frequently retaining all their essential features as aqueous rocks:—the marks of bedding still easily seen:—the remains of plants, shells, teeth, and bones, still common:—it is not rare to find some of these clays converted into slates, and it is yet more usual to find them alternating with calcareous or irony bands, as already alluded to. These are not unusually collected round some group of fossils, acting perhaps as a disposing cause for the separation. The slates are yet more striking illustrations of change; and in them also occasionally shells and other fossils, little altered, indicate a water origin. Water currents, acting under enormous pressure, have so far altered clays that they have become slates. But the veins, or cracks and crevices that abound in slates, are filled with quartz in a crystalline state. These are often full of holes, and within them sometimes iron pyrites, sometimes valuable ores of copper, make their appearance. But in the deposits of ore there is still no appearance that is not more readily explained by the action of water than by fusion. Currents of heated water—electric currents passing through the earth in definite courses—these would seem to have been the agencies in producing all the transformation and metamorphosis of the richest metalliferous rocks of Cornwall and other countries where mining is carried on in slate.

When we examine such rocks as granite and the large group of compounds of which it is the type, we enter on more doubtful ground, and must therefore tread more cautiously. These have long been held as the proof of igneous action, and few are prepared on first examining them to attribute any of them to mere change in contact with water. But here again we are bound to look to the facts of the case—*esse quam videri* must be our motto.

And first there is the texture and appearance of granite itself as compared with rocks we know to have been molten, such as lavas, ancient or modern. Here the microscope comes into use, and teaches us that a very large class of rocks, of which granite is one, have, beyond all doubt, been formed in contact with water, for water in a fluid state is actually mixed up with them, and is contained within the separate crystals of which they are constructed. That granites, syenites, and greenstones, with the host of rocks of the same or nearly the same general character, which we may call porphyries for want of a better name, have been formed with water, there can indeed be no longer a doubt; but it is still uncertain what temperature has been needed to produce them.

That they have, however, in some cases, been produced by the change or metamorphism of regularly stratified rocks, and in the very midst of such rocks—some underlying them and some overlying—that certain parts of slates and such like rocks have been converted, or metamorphosed into granites, while other parts adjacent have not been more altered than slates generally are, is rendered so probable by the study of actual rocks in the field, that if not fully accepted as proved it must still be regarded as one of those matters to be expected, and of which there is every probability. There are now many places described in England, Wales, and Ireland where granites and porphyries of various kinds fairly alternate with slates and other rocks, where it is so utterly improbable that they can have been forced in between those rocks after being once formed, and so certain that they could not have been thrust in in a melted state, that we are forced to the conclusion above stated, namely, that granite also is metamorphic; that like the rest it is due to water rather than fire.

The reader may be prepared to ask how it is that chemical changes so energetic, transformations and replacements so complete, and metamorphoses on a scale so gigantic are consistent with the ordinary state of apparent tranquillity of the interior of the earth. The rumblings of earthquakes, though certainly not infrequent, are limited to very small area; the eruptions of volcanoes are very much more limited, and are altogether exceptional phenomena, occurring on a large scale only once or twice in a century. But the changes we speak of must be incessant, and their amount must be large. Their effects are everywhere.

We reply that the apparent repose of the earth is not real; that as the giant oak standing firmly rooted in the earth, and for centuries unmoved by the fiercest storm, owes its apparent uniformity of condition to changes incessantly going on within, and to ceaseless currents of sap that circulate through its whole tissue—that it only lives, and is strong, because of this continual change and replacement that we call life; so the great old globe itself has its life, its fluids circulating throughout, removing, replacing, modifying, and renewing. Everything in nature is in perpetual circulation, and water passing everywhere is the circulating medium. It is the earth's blood, preserving life, replacing the old and worn-out material by new material, separating that which has performed its work, and putting it in the way of entering into new combinations, and enabling it to come in once more as a useful element.

But there is something besides, for the word life has a different and a higher meaning. Vitality requires not only a circulating fluid, but a certain energy, which in the animal we

connect with the nervous system. Those currents of earth magnetism, obtained in some mysterious way from the sun, and passing from pole to pole of the earth, both above and within the surface:—recognized in the air by one kind of phenomena, and now well recognized in the substance of the earth by their effects on the telegraph wire:—those electric forces induced by and governing chemical change, such as the passage of currents of water through different minerals cannot fail to produce; all these are the representatives of nervous energy in the earth, while all, so far as we know, are strictly superficial phenomena. Lastly, there is vital heat, represented in the earth also by the higher and equable temperature at moderate depths.

These inquiries have nothing to do with doubtful questions as to the earth's nucleus and its temperature now, or at any previous period; they are fair questions for discussion, for they admit of experimental investigation, and they tend to place geological science on its right footing, apart from mere idle theory and baseless assumption. Thus we know that water can traverse all rocks, and we have the best possible reason for believing that it does so. We know that it is capable of dissolving almost every element, and that it acts energetically on most rocks when containing certain acids which are constantly provided. We know that earth-magnetism is a reality, and that magnetic and other forms of electricity are convertible; we can hardly doubt also that heat and electricity and chemical action are mutually convertible, and in the strictest sense are co-relative. We know that chemical action induced by the passage of water under certain circumstances must involve changes of temperature, and that the increment of temperature thus produced may be very great. There is really no need for the assumption of a central fire, even to account for the steady increase of temperature observed at increased depths. We have no right to introduce the *Deus ex machinâ* when the ordinary machinery is sufficient, and so long as we can explain metamorphism by methods of nature that we understand and can copy; so long, in a word, as water will serve our purpose, it is certainly not philosophical, nor is it altogether reasonable, to allow ourselves to be prejudiced by vague resemblances, which, when traced to their foundation, are found to be little more than analogies.

Metamorphism, then, is a great fact in nature. Every fragment of limestone, sandstone, and slate, or shale, that enters into the composition of the rocks of the earth, is more or less metamorphosed; every fossil that is found bedded in rocks is likewise changed, and shows metamorphism. It is not only the granites and other crystalline rocks that have been so much altered that their original texture and history are lost sight of;

but all other rocks in all countries tell the same tale. There are proofs of this, and illustrations of the mode of change everywhere, and the great agency employed has certainly, in most cases, been altogether unconnected with heat and igneous fusion. The very oldest rocks, even those lowest in the series, all speak by their nature, structure, and composition of other rocks still older, all, without exception of the stratified series, have been derived by the aid of water from the destruction of some of yet greater antiquity. And amongst rocks of all ages are the granites: in rocks of all ages are veins of greenstone and such like mineral compounds. Were all these thrust up in a melted state through the stratified rocks and amongst them, or have they not rather been deposited where we see them in a more quiet way by the help of water acting under favourable conditions of temperature and chemical force? These are important questions in modern geology. It is certain that granites and porphyries are not all of the same date, but that some have lasted little altered during whole geological periods, while others have been elaborated in recent times. But so it is also with slates, and schists, and limestones, for some of these are new and some old, although the appearances hardly vary. There is no great heat required for most of the changes, and, in fact, many of them are absolutely inconsistent with the presence of such an amount of heat as would produce fusion.

On the other hand water and its known action afford the only simple and intelligible explanation of a large class of phenomena, and will explain the universal difference traceable between recent deposits and those that have long been deposited, and have undergone change of position and exposure to the causes at work beneath the earth's surface. Water and fire are two important agents employed by nature, and both assist in the same great work—that of inducing chemical and atomic change. Both seem to produce, or at least to pave the way for decomposition and re-combination. Each is powerful, and opposite as they seem, both work together in the production of all great results in nature. Near the earth's surface, however, water acting at moderately high and equable temperatures, and under pressure, would seem to be nature's method of bringing about the largest results, and this seems to be not only the case at present, but to have been equally the case in the very earliest times which geological investigation introduces to our notice. The only clear and unmistakeable proofs of igneous action that we possess are the modern lavas, and those ancient sheets of lava called basalt, that have clearly been ejected in a molten state, and have spread themselves in thin sheets over the surface. These at all times seem to have been partial, and on a small scale, and would appear to have few if any relations

with the larger metamorphoses which we have been considering in the present article.

In conclusion, however, let the reader be advised, if not yet familiar with the practical work of geology, to accept no theory, and be bound by no respect for established authorities in this matter. Geology is a subject for study, and not for dogmatic statement. It is not desirable to raise another such storm as that which disturbed the serenity of the scientific horizon when the aqueous and igneous theories were first propounded. We need not shut our eyes to truth because it seems opposed to opinion, but we should observe closely and avoid coming to conclusions too rapidly. Metamorphism is a great and difficult subject.

ATMOLYSIS.

BY W. B. TEGETMEIER.

In the previous volumes of the Intellectual Observer* will be found notices of the discovery of the phenomena of Dialysis, by Mr. Graham, the Master of the Mint; of its application in the explanation of natural occurrences, such as the formation of minerals, and also of its practical utility when applied to the arts of life and civilization. Mr. Graham has been continuing these investigations with that profound originality of research that has caused him to be regarded by scientific men as one of the most illustrious investigators in the highest branches of physical science.

The phenomena attending the passage of liquids through thin membranes constitute what is termed dialysis. Those under consideration at present, depend on the passage of gases through porous plates.

Mr. Graham commenced this train of investigation many years since, and, from time to time, some of his results have been made known. The instrument originally employed in these researches was termed a diffusiometer, and consisted of a plain, cylindrical glass tube, one inch in diameter, by ten inches in length. This, by being closed at one end by a thin plug of plaster of Paris, was converted into a receiver capable of being used over mercury. At the present time, compressed graphite has been substituted for the plaster of Paris; this is obtained by cutting slices with a fine steel spring-saw off the compressed blocks used for the manufacture of pencils. These slices, by rubbing down on a dry sandstone, can be obtained

* Intellectual Observer, vol. i. pp. 156 and 381; vol. ii. p. 224.

of a degree of thickness not exceeding one-half a millimetre, about the thickness of an ordinary wafer: one of these plates attached by cement to the end of a glass tube closes it and forms a diffusiometer. During the process of filling over a mercurial trough, the porous plate is covered with a thin sheet of gutta-percha; on removing which, diffusion immediately takes place.

If one of these tubes be filled with hydrogen, it is found that the gas will totally diffuse itself into the air in the space of about forty minutes; about one-fourth as much air passing through in the reverse direction, and the mercury rising against the influence of gravity, to supply the space left by the more rapid diffusion of the hydrogen.

It is found that the pores of the compressed graphite are so minute, that the gas in a mass does not pass through, but that the molecules only pass by a sort of intestine motion. According to the hypothesis advanced to account for this circumstance, gases consist of perfectly elastic atoms which move amongst each other with different degrees of velocity in the different gases; and when the gas is confined in a close vessel, the atoms impinge against the sides and against each other, but that this occurs without any loss of velocity owing to their perfect elasticity.

If, however, the sides of the vessel are porous, the atoms moving against the open channels escape, and, in the same manner, the air or any gas which may be external to the vessel, enters. When the same gas is on both sides of a porous vessel, the interchange takes place, but it is not attended with any alteration of bulk of the contained gas. In the case of some gases which diffuse at the same rate, as for example, nitrogen and carbonic acid, the interchange takes place without any change of volume. But with gases having an unequal molecular velocity, as air and hydrogen, the diffusion is unequal.

The further investigations of Mr. Graham relate to the laws affecting the passage of a gas, either by pressure or by its own elastic force, through a graphite plate in one direction only, a vacuum being maintained on the other side. A gas may pass into a vacuum in three different modes:—

1. When a gas passes into a vacuum through a minute aperture, as a hole in a plate of platinum foil, its rate of passage is regulated by its specific gravity. "A gas," says Mr. Graham, "rushes into a vacuum with the velocity which a heavy body would acquire by falling from the height of an atmosphere composed of the gas in question, and supposed to be of a uniform density throughout. The height of the uniform atmosphere will be inversely as the specific gravity of

the gas, the atmosphere of hydrogen being, for instance, sixteen times higher than that of oxygen; but as the velocity acquired by a heavy body falling is not as directly the height, but as the square root of the height, the rate of flow of different gases into a vacuum will be inversely as the square root of their densities. The velocity of oxygen being 1, that of hydrogen will be 4, the square root of 16. This law has been experimentally verified," and the mode of passage is termed *Effusion*.

2. If the aperture be in a plate of increased thickness, the law of effusion no longer holds good. When the length of the tube exceeds the diameter by 4000 times, a new ratio is established, that of the *Capillary Transpiration of Gases*. The rates of transpiration are not governed by specific gravity, and are singularly unlike those of effusion, the transpiration velocity of oxygen being 1, that of chlorine is 1·5, and that of hydrogen 2·26. These ratios appear in constant relation to no other known property of the gases, and they form a class of phenomena remarkably isolated. Exceedingly minute capillary tubes, however numerous, offer practically a perfect impediment to the passage of gas by transpiration.

3. The diffusive, or molecular movement of gases, enables them readily to pass through plates of graphite which are, practically, impenetrable to gas by either of the two preceding modes; this penetration appears to be due entirely to their own proper molecular motion, entirely unaided by transpiration, and uninfluenced by pressure. The graphite appears, as it were, to become a molecular sieve, allowing molecules only to pass through, and, consequently, hydrogen is found experimentally to pass through a graphite plate with precisely the same velocity, whether it is passing into a vacuum or into air.

These abstract investigations of Professor Graham have already been pressed into the service of practical science. An instrument termed an *Atmolyser* has been designed, by means of which mixed gases of different diffusibility can be separated. The most remarkable effects of separation are produced by the *tube atmolyser;* this is simply a narrow tube of unglazed earthenware, similar to a tobacco pipe stem, two feet in length, which is placed in a shorter tube of glass, and secured in its position by corks, so as to resemble in appearance a Liebig's condenser; the glass tube is then exhausted of air by being connected with an air-pump, and a mixed gas is allowed to flow through the earthenware tube, when the more diffusive gas is rapidly abstracted. Thus, when an explosive mixture of two volumes of hydrogen and one of oxygen is passed, the gas issuing from the tube consisted of oxygen, with less than 10 per cent. of hydrogen—a mixture which could not be ignited.

These considerations of these phenomena have led Mr. Graham into certain speculations respecting the constitution of matter. It is conceivable that the various kinds of matter, now regarded as different elementary substances, may possess one and the same ultimate molecules in different conditions of movement. The essential unity of matter is a hypothesis in harmony with the uniform action of gravity on all bodies; we may imagine one substance only to exist, namely, ponderable matter, and that this is divisible into ultimate atoms, uniform in size and weight; if these atoms were at rest the uniformity of matter would be perfect. But they always possess more or less motion due to some original primordial impulse; this motion gives rise to volume; the more rapid the motion the greater the space occupied by the atom. Thus, matter of different density forms different substances, that are usually regarded as different inconvertible elements, and this hypothesis may be pursued through the various phases of combination; the different states of solid, liquid, and gas, and the colloid and crystalline forms of matter.

Recent as are these discoveries and speculations of the author, they have already a practical bearing on the communication of heat to or from gas or vapours, by contact with solid or liquid surfaces; for the impact of the gaseous molecule on a surface possessing a different temperature from itself appears to be a condition of the transference of heat from one to the other. The more rapid the molecular movement of the gas, the more frequent the contact, and, consequently, the more rapid the communication of heat. Hence, the great cooling power of hydrogen as compared with that of air or oxygen. These gases have the same capacity for heat, as regards equal volumes; but a hot body placed in hydrogen is really touched 3·8 times more frequently than it would be if placed in air, and 4 times more frequently than it would be in an atmosphere of oxygen. This property of hydrogen recommends the application of that gas to the air or caloric engine, where the object is alternately to heat and cool a confined volume of gas with great rapidity.

There can be no doubt but that engines worked by steam, the employment of which is always attended with so great a loss of heat, will eventually be superseded by air or caloric engines, where there is no loss by condensation. Theoretically, air engines are perfect, and the practical difficulties that prevented their adoption are being gradually overcome.

THE TINNEVELLY PEARL BANKS.

BY CLEMENTS R. MARKHAM, F.S.A., F.R.G.S.

FROM time immemorial the pearl fishery in the narrow sea which separates India from the island of Ceylon has been famous in all the marts of the old world, and has rivalled the still more renowned fishery of Bahrein, in the Persian Gulf. Opinions have always varied respecting the value of the pearls from these fisheries. Tavernier, the old travelling jeweller, said, in 1651, that the pearls from the sea that washes the walls of Manaar, in Ceylon, are, for their roundness and water, the fairest that are found, but rarely weigh three or four carats. Master Ralph Fitch, a London merchant, who made a voyage to the Indies in 1583, says, on the other hand, that, though the pearls of Cape Comorin are very plentiful, they have not the right orient lustre that those of Bahrein have. Whatever the truth may be respecting the water and orient lustre of the pearls of these rival fisheries, there can be no doubt that a vast concourse of merchants and others has been annually attracted to the fisheries in the Gulf of Manaar from the most ancient times, which is sufficient evidence of their value.

The Ceylon fisheries have retained their old reputation down to modern times. But it is to the smaller and hitherto less productive pearl banks, on the opposite side of the Manaar gulf, off the shores of the Indian Collectorate of Tinnevelly, that the reader's attention is requested. An experiment, with a view to the improvement of the fishery, has now been commenced there, which possesses considerable scientific and general interest.

In the golden age of the Tamil people of Southern India, the Tinnevelly pearl fishery, then established, as Ptolemy states, at Kôru, the more modern Coil, paid tribute to the Pandyon kings of Madura; and at this period, we are told by the author of the Periplus of the Erythræan Sea, none but condemned criminals were employed in the fishery. Marco Polo, in the end of the thirteenth century, mentions the land of Maabar,* where many beautiful and great pearls are found off the coast. The merchants and divers, he says, congregated at Betaler, in April and May, and he relates how the divers, called *Abraiamain*, performed incantations to preserve themselves from the attacks of great fish in the depths of the sea.

* *Maabar* of Ibn Batuta and Marco Polo is the southern region of the Coromandel coast, comprised in the modern districts of Madura and Tinnevelly. Colonel Yule has suggested that the word may be Arabic (*Ma' abar*, a ferry), in reference to the passage or ferry to Ceylon.

In those days the sovereign received a tenth, and the divers a twentieth of the proceeds of the fishery. The great number of pearls from these Tinnevelly banks excited the wonder of all the bold wanderers who completed the perilous voyage to India in early times. Friar Jordanus, a quaint old missionary bishop, who was in India about 1330, says that 8000 boats were then engaged in this fishery and that of Ceylon, and that the quantity of pearls was astounding, and almost incredible. The head-quarters of the fishery was then, and indeed from the days of Ptolemy to the seventeenth century continued to be, at Chayl or Coil, literally "the temple," on the sandy promontory of Ramnad, which sends off a reef of rocks towards Ceylon, known as Adam's Bridge. Old Ludovico di Varthema mentions having seen the pearls fished for in the sea near the city of Chayl, in about 1500 A.D., and Barbosa, who travelled about the same time, says that the people of Chayl are expert jewellers who trade in pearls. This place is, as Dr. Vincent has clearly shown, the Kôru of Ptolemy, the Kolkhi of the author of the Periplus, the Koil or Chayl of the travellers of the middle ages, the Ramana-Koil (temple of Rama) of the natives, the same as the sacred promontory of Ramnad and isle of Rameswaram, the head-quarters of the Indian pearl fishery from time immemorial.

But Tuticorin, the present head-quarters of the fishery, has supplanted the ancient Coil for the last two centuries; and, since the middle of the seventeenth century, the powers which have successively presided over the fishery, whether native, Portuguese, Dutch, or English, have uniformly taken their station at this little port, which is about ninety miles north-east of Cape Comorin, on the Tinnevelly coast. When the Portuguese were all powerful on the coast, the Jesuits were allowed the proceeds of one day's fishing, and the owners of the boats had one draught every fishing day. The Naik of Madura, the sovereign whose family succeeded the ancient Pandyon dynasty, also had the proceeds of one day as Lord of the coast. These Naiks were the builders of all the magnificent edifices which now beautify the city of Madura, and their dues from the fishery were probably used as offerings to Minakshi, the fish-eyed goddess of the vast Madura pagoda, who now possesses, amongst her jewellery, a numerous collection of exquisitely beautiful pearl ornaments. In the days of the Naiks and Portuguese there were 400 or 500 vessels at the annual fishery, carrying sixty to ninety men each, a third of whom were divers; and at the subsequent fair held at Tuticorin there was an assembly of from 50,000 to 60,000 persons. The divers, at that time, were chiefly Christians from Malabar. Captain Hamilton, who was travelling in the East from 1688 to 1723,

described Tuticorin when the Dutch were all powerful at that port, as well as in Ceylon. He says that a Dutch colony at Tuticorin superintended a pearl fishery a little to the northward of the port, which brought the Dutch company £20,000 yearly tribute.

The Dutch appear to have fished too recklessly and too often; and, when the English succeeded them at Tuticorin, the banks were very far from yielding £20,000 a year. Our predecessors had well nigh killed the goose with the golden egg; and for many years we followed in the same track. It is the old story: a valuable product is discovered to be a source of considerable wealth, and forthwith a system of reckless destruction for the sake of immediate gain is inaugurated. Then the supply begins to fail—a panic ensues; and, when science and forethought are called in, it is discovered that ordinary prudence and a judicious system of conservancy would have ensured an annual unfailing yield from the first. Such has been the history of Chinchona bark in South America, of the teak and other timber of the Indian forests, and such also is the story of the Tinnevelly pearl banks since the Dutch times.

In 1822 the Tuticorin pearl fishery contributed about £13,000 to the Indian revenue, and in 1830 about £10,000; but after the latter date there was no yield at all for many years. Between 1830 and 1856 there were thirteen examinations of the banks, and on each occasion it was found that there was not a sufficient number of grown oysters to yield a profitable fishery, and none was therefore attempted. The unsatisfactory condition of the banks was attributed to several causes. Captain Robertson, the Master Attendant at Tuticorin, thought that the widening of the Paumben channel, which caused a stronger flow of current over the banks on the coast, prevented the molluscs from adhering; and that the fishers for large conch shells called *chanks* (which are used as horns in the worship of idols, and cut into segments of circles as ornaments for women's wrists), anchoring their boats on the banks, killed the oysters. The dead oysters would, of course, have a fatal effect on their neighbours. The native divers attributed the state of the banks to the pernicious influence of two other shell-fish, called *soorum* (a kind of Modiola) and *kullikoz* (an Avicula), which are mingled with the pearl oysters on the banks, and, as the natives believe, destroy them.

In 1856, however, an examination was made by Captain Robertson, and it was found that at least four of the banks off Tuticorin, called *Cooroochan Paur, Navary Paur, Oodooroovie Paur,* and *Clothie Paur* were well covered with young pearl oysters, which would be old enough to be fished in 1860-61. The Madras government, therefore, determined that every pre-

caution should be taken, in order that the banks might receive no injury during the interval. The chank fishery off Tuticorin was ordered to be entirely put a stop to at the termination of the contract, and vessels were provided to protect the pearl banks from poachers, on board one of which Captain Robertson was unfortunately lost in March, 1859.

Captain Robertson was succeeded as Master Attendant of Tuticorin and Superintendent of the Tinnevelly Pearl Banks by Captain Phipps, to whose zeal and intelligence the fishery owes its present hopeful condition, and under whose auspices the fishery of March, 1860, the first that had been attempted since 1830, was opened.

A Government pearl fishery is a most legitimate source of revenue, and forms an exception to all other monopolies; which, as a rule, have in modern times been justly condemned. But pearls are simply articles of luxury in the strictest meaning of the word; the seas in which they grow cannot well become private property; and, if a profit can be derived from their sale, it is certainly a branch of revenue which can give just cause of complaint to no man, while it benefits the community at large. In India, too, the Government are possessed of advantages which enable them to get the work of superintendence and management done with far greater economy and efficiency than could be secured by any private individual or company. So high an authority as Mr. McCulloch has taken an opposite view, and says that the Government monopoly ought to be abolished, because the expense of guarding and managing the banks exceeds the sum for which the fishery is let, and that any one who likes should be allowed to fish on paying a moderate license duty. The last edition of the *Commercial Dictionary* was published in 1860, and during the two following years the Tinnevelly pearl fishery yielded a large nett revenue to the Government, which is a sufficient answer to Mr. McCulloch's argument. It is true that there has since been disappointment; but the way to secure regular annual returns is by adopting a carefully considered scientific system of conservancy, and not by throwing the banks open to the depredations of all comers.

The fishery of 1861 commenced on March 7th, and the sale of the Government share of oysters was conducted by public auction, which began at Rs. 15, and gradually rose to Rs. 40 per 1000. As many as 15,874,500 shells were sold, realizing upwards of £20,000, as the nett result to Government, exclusive of all expenses, and of the shares allowed to the divers. The annual expense of the guard boats for protecting the banks is only £500.

In 1862 the results of the fishery were also satisfactory;

but in 1863 the banks were found to be in a most unpromising state, and no fishery was attempted. Out of seventy-two banks that were examined, only four contained oysters free from *soorum*, eleven had young oysters mixed with *soorum*, and fifty-seven were blank. It is this unexpected failure of properly-grown shells which has given rise to Captain Phipps' experimental culture now in course of trial, and to a very careful consideration of the conditions most likely to secure a good annual fishery, which shall not be liable to this periodical sterility.

The pearl banks are about nine miles from the shore, and 8 to 10 fathoms from the surface, being scattered over an area 70 miles in length. They are exposed to ocean currents, which, by washing sand into the interstices of the rocks, often destroy the young oysters over a considerable area; the dead fish, when not removed, soon contaminate their neighbours; and, in addition to these sources of evil, the *soorum* shells, a species of Modiola, like a mussel with a swollen face, which often grow amongst the pearl oysters, exercise a pernicious influence, either by dying and spreading death around them, or by accumulating sand. It is obviously quite impossible to watch these banks efficiently, and to eradicate the evils caused by sand accumulations and dead molluscs, owing to their great depth and exposed situation in the open sea at a distance from land. Unless some plan is adopted for rearing the young fish on banks which shall be constantly accessible, and free from the above drawbacks, the fishery will always be liable to failures, sometimes of long duration. The perfection to which science and intelligent care have brought the fisheries of edible oysters on the English, and especially on the French coasts, leaves no doubt that equally satisfactory results might be obtained from similar measures on the Tinnevelly pearl banks.

A few remarks on the habits of the pearl oyster will make this part of the subject more clear.

It is, perhaps, unnecessary to observe that the pearl oyster (*Meleagrina margaritifera*, Lam.) is not in reality an oyster at all, but is more allied to a mussel; having, like the latter animal, a *byssus*, or cable, by which it secures itself to the rocks—one of the most important points in its organization. The animal's foot is composed of muscular fibres, and is 2½ inches long, when distended. On the lower side there is a groove lined by a secreting membrane, which is an exact mould for the formation of the *byssus*. When the animal desires to attach itself to the rock, its foot is protruded, and, after seeking out a suitable spot with the tip for some minutes, is again retracted into the shell. A strong fibre, of the form

of the groove in the foot, is thus left, attached to the base of the foot at one end, and to the rock at the other. The process is again and again repeated until a strong cable is formed; and it was one of the most important results of the careful investigations of Dr. Kelaart in Ceylon, that the power of the animal to cast off its *byssus* at pleasure was ascertained. It leaves it behind to make another in a more convenient place, like a ship slipping her cable and going to sea. From this ability to shift its berth it follows that the pearl oyster might safely be taken from its native beds, and made to colonize other parts of the sea; and also that it would move of its own accord if the surrounding water should become impure or sandy, or when there is an influx of fresh water. The animal can re-form the *byssus* at pleasure, if in good health and condition.

The formation of pearls is another point which has received much attention, but which has not as yet been definitively settled. Pliny and Dioscorides believed that pearls were productions of dew, but that observant old Elizabethan navigator, Sir Richard Hawkins, shrewdly remarked that "this must be some old philosopher's conceit, for it cannot be made probable how the dew should come into the oyster." Modern investigation has suggested various causes for the intrusion of the nucleus round which the pearl is formed. The free border of mantle lining each valve of the shell dips downwards to meet a similar edge on the opposite side, thus forming a double fringed veil. The tentacles of this fringe consist of long and short flat filaments, which are exceedingly sensitive, so that even the approach of a foreign substance makes them draw forwards and shut out the intruder. They doubtless prevent the pearls from dropping out of the shell, and preserve the fish from the host of carnivorous creatures which infest its place of abode; and if it be true that particles of sand form the nuclei of pearls, they must run the gauntlet of these ever-watchful sentinels before they can intrude themselves amongst the interstices of the mantle. The food of pearl oysters consists of foraminifera, minute algæ, and diatoms; and Dr. Kelaart has suggested that the siliceous internal skeletons of these microscopic diatoms may possibly permeate the coats of the mantle, and become nuclei of pearls.

Lastly, the *ova* which escape through the distended coat of an overgrown *ovarium* may, perhaps, become embedded in the interstices of the mantle, and become the nuclei of pearls, especially as pearls are usually found embedded in the mantle near the hinge, where the *ovarium* is most liable to rupture. Large pearls often work their way out of the mantle, and lie loose between it and the shell, or become attached to the surface of the latter. They have even been found outside

the shell altogether, entangled amongst the strands of the *byssus*. When the pearl banks are under constant supervision, the causes leading to the formation of pearls, as yet imperfectly understood, will, doubtless, receive close attention.

It now only remains to describe the plan by which it is hoped that, in future, the Tinnevelly pearl banks will be kept supplied with a sufficient number of well-grown shells to supply a remunerative annual fishery. The idea was suggested by the method adopted with regard to edible oysters on the English and French coasts. The chief external difference between the pearl and edible oyster is, that the former secures itself to rocks and stones by means of a *byssus*, while the latter merely lies flat on the ground on its convex side; but there is no reason why the pearl oyster should not thrive on artificial banks as well as the edible oyster.

In the Colne oyster fishery, the *brood* (oysters two years old) are dredged up out at sea, and placed on "*layings*" within the river Colne. These "*layings*" are about 100 or 150 yards by 80, according to the breadth of the channel, most of them dry at low water, and they are paved with stones, old shells, and any other hard substances, to a depth of a few inches, so as to form a bed for the oysters, which would be choked in soft mud. This material is called *culch*. In France, M. Coste has adopted a system of placing fascines on the *layings*, instead of *culch*, as resting places for the oysters; but the natural advantages of the ground render any artificial method of this kind unnecessary in the Colne. It is very important that the *culch* should be kept perfectly clean and clear of mud, and, above all, that every mussel-shell should be weeded out. The mussels have a remarkable tendency to collect mud round them in heaps, probably owing to their elongated shape, and if they are allowed to remain on the *layings*, there is danger of the oysters being choked with mud. The oysters remain on the *layings* for two years, when they are fit for eating, and during this time there are constant examinations, in order that all dead fish may be removed, and the *culch* kept clear of mud. In places where the layings are never laid bare by the tide, this is done by means of a dredge, all live fish and *culch* being carefully thrown back, while dead fish, soft mud, and mussels are removed.

There can be little doubt that some such system might be adopted in rearing pearl oysters, and Dr. Kelaart says that "he sees no reason why pearl oysters should not live and breed in artificial beds, like the edible oysters, and yield a large revenue." He has ascertained, by his experiments in Ceylon, that the pearl oysters are more tenacious of life than any other bivalve with which he is acquainted, and that they can live in brackish

water, and in places so shallow that they must be exposed for two or three hours daily to the sun and other atmospheric influences. Captain Phipps, the superintendent of the Tinnevelly pearl banks, has come to the same conclusions; and, convinced that artificial nurseries for the young oysters are the only means by which remunerative fisheries can be ensured, he has proposed the following plan, which has been adopted:—

The harbour of Tuticorin is formed by two long islands, and between them and the mainland there is a bank about three miles long by a quarter of a mile broad, with a depth of from three to seven feet, entirely free both from surf, currents, and influxes of fresh water. Captain Phipps proposes that this bank should be walled round with loose coral until it is formed into a basin, the edges rising three feet above high water mark. Over the bed of the shallow basin thus enclosed, live coral will be regularly spread, so as in a few years to form a solid mass, serving the purpose of *culch*, and the basin will be divided into three parts, one for the old oysters, and the other two for the young ones that may be in process of rearing. After the division of the basin set apart for breeding has been stocked, it will be carefully watched, and when the spawning has taken place and the young oysters are well formed, they will be removed from the old oysters and rocks to which they are attached, and placed in one of the separate parts of the basin, and the same plan will be followed each succeeding year. On reaching a sufficient age, they will again be removed to one of the pearl banks in the open sea. The last operation is necessary, because it would be impossible to enclose an artificial space which would hold as many grown oysters as are required for a remunerative fishery, and because it is believed that the quality of the pearl depends on the depth and clearness of the sea in which it has been formed.

A single oyster, five or six years old, often contains no less than 12,000,000 eggs, and in the fishery of 1861 the total number taken only amounted to 15,874,500, so that the number of young ones annually obtained from the nursery will be abundantly sufficient to stock banks for each year's fishery. Care will of course be taken that only such banks are selected for stocking as have the rocks which compose them raised well clear of the surrounding sand.

By this system, adapted as it is from those of the English and French edible oyster fisheries, several advantages will be secured, and all the dangers to which the pearl oysters are now exposed will be avoided. The young growing molluscs, safe on their carefully watched *laying* at Tuticorin, will be secured from the choking sands of their natural banks, as well as from their alleged enemy, the *soorum*, the effects of which

are probably the same as those caused by the mussels on the edible oyster *layings* in the Colne. It is during the period of their growth that the pearl oysters are so exposed to these dangers, and very frequently banks have been found well stocked with young oysters, and giving promise of a lucrative fishery, at a preliminary examination, which, when the time for the fishery arrives, are bare, all their inhabitants having died and been washed away. But if preserved during the period of growth in the artificial nursery, and only placed out when they have reached maturity, the oysters can then form their pearls in security until the season for the fishery arrives, and well stocked pearl banks may be reckoned upon for each year.

Thus it is hoped that, by adopting these carefully considered plans, and improving upon them as experience and watchful investigation dictate from year to year, a regular and unfailing source of revenue will be secured to the State, and the Tinnevelly pearl banks will, after laying dormant for thirty years, regain the immemorial renown which was conceded to them, alike in the days of Ptolemy, of Marco Polo, and of Hamilton. They form the most ancient fishery in the world, and, now that science and careful supervision have been supplied, they will no longer be the least remunerative.

MICROSCOPE TEACHINGS.*

It is very easy to write a popular twaddle about science, but rare is the talent by which science is really popularized. For the first and useless performance, very slender knowledge is required, but the last requires both accuracy and depth. It also demands the enviable faculty of reducing a subject to its simplest elements, and presenting them in a pictorial and suggestive form. It is not enough to narrate facts, for unless they are judiciously expounded they remain in the mind as so many dead seeds destitute of germinating power. We often see this in pupils who have been well crammed by Mr. Feeder, B.A., or by his feminine counterpart, who is stuffed with Magnall's questions, impregnated with latitudes, carries dates on her fingers' ends, and diffuses an odour of the rule of three. The more people are taught after this fashion, the greater nuisance

* *Microscope Teachings:* Description of various Objects of especial Interest and Beauty adapted for Microscopic Investigation, illustrated by the author's original Drawings, with Directions for the Management of a Microscope, and the Collection and Mounting of Objects. By the Hon. Mrs. Ward, author of *Telescope Teachings.* London: *Groombridge and Sons.*

they are to their neighbours, and the less serviceable their minds become to themselves. They do not, properly speaking, *know* anything, because reflection has never been cultivated, and their imaginations have grown dull under a cumbrous load of ill-assorted materials. Widely different is the result of real teaching, whether its lessons are communicated orally, or reach the student through the medium of books. This is always conducive to mental growth and health, whatever form it takes, but perhaps never more so than when it charms the eye and the fancy with scenes of beauty from the world of nature, and extracts its lessons of wisdom from objects that gleam upon us from the heavens, or surround us on the earth. The advanced students of nature, if fitted for their work, are in the position depicted by Wordsworth in his *Prelude*. Without wrongful egotism they may exclaim,

> "What we have loved
> Others will love, and we will teach them how;"

and it is indeed a noble task to be the pioneers and guides into regions of truth and loveliness, infinite in their variety, perennial in their charm.

To the Hon. Mrs. Ward must be assigned an excellent place among these pioneers and guides. In her *Telescope Teachings* she has provided an admirable beginning for astronomical study, and her work on the microscope is by far the best that has been produced for the particular object its author had in view. It is, as befits an introduction to a delightful branch of practical science, an elegant book, enjoying all the advantages of excellent paper, large type, beautiful coloured plates, and handsome binding. The moment it makes its appearance in a civilized family there will be a rush towards it, and it will seldom fail to convert its readers into microscopists if they can obtain an instrument to work with as it directs.

Microscope Teachings is divided into twelve chapters, the two first giving very clear and useful information on microscopes, and the various processes and precautions necessary for their use. This will prove valuable to many purchasers of instruments, who often experience bitter disappointment after the optician has sent their instrument home, because no one is at hand to explain the details of manipulation, without which nothing but failure can arise. With Mrs. Ward's book they would make no mistakes, and her advice would guide them wisely in the selection of an instrument according to the expenditure they wished to make. Beginners should not be caught by the glittering appearance of a new microscope, and the number of articles supplied for a given sum. What they want is "that the microscope shows objects clearly, and is perfectly

achromatic, that is, without those fringes of rainbow colours always seen surrounding objects in inferior microscopes. It should also be constructed to lean backward, as being far less fatiguing to the observer than the upright position. It should have at least *two* different degrees of magnifying, and one of them should be of low power, with large field of view, for the purpose of showing as much as possible of an object at once. These, with the condensing lens, and mirror to throw light on or through objects, are things indispensable." A reference to our advertising pages will show how cheaply these necessaries can be obtained, and although those who have money to spare will be sure to want a superior instrument if they continue the pursuit, a comparatively simple one, judiciously selected, will serve all ordinary purposes of investigation or display. After giving information and advice, which every beginner will be glad of in learning to use a microscope, Mrs. Ward describes the methods of collecting and mounting objects, and then, in the fourth chapter, begins her list of objects with the structure of insects' wings. This chapter is illustrated by many, exquisitely-drawn, and coloured, figures from her own pencil, and is appropriately followed by another chapter on "the scales of insects and fish," which likewise supply beautiful plates. The objects described in these and other chapters are for the most part easily obtainable, and this is important, because, although it is both useful and pleasant to have a collection of slides prepared by professional mounters, the most substantial knowledge will be gained by collecting and mounting for ourselves. Every one ought to do this to a certain extent with reference to every class of object, even if the cost of prepared slides is of no importance; and those which are bought or given will be much better understood if the student has prepared something of the same kind for himself.

As a specimen of Mrs. Ward's directions we will cite her account of how to obtain the scales of the eel—a beautiful structure, which few who are in the habit of eating the creature take the trouble to behold. Our author says, "When I first began to prepare objects for the microscope, I read in some old book that these were worth looking at, so I procured a dry piece of eel skin, but it was long before I could find what I was in search of. I scraped and scraped with a knife, and examined the scrapings with a microscope, magnifying them twenty times—forty times—perhaps 100; but no scales appeared. I forget how I contrived to make them out at last; but, if I take a little piece of eel skin, and view it as a transparent object, magnified rather more than four diameters, the first thing I see is that the skin is covered with star-like spots, and next I observe the scales lying close together. And this is the way to

get at them: I take the little scrap of skin and tear it in two, exactly as if I were splitting a card, for the skin consists of two layers. I can easily lift them off with a knife and mount them for the microscope, while the skin makes another very pretty object for it, not unlike the spotted coat of a leopard."

Mrs. Ward's sixth chapter is devoted to hair and feathers; and, like the preceding, is beautifully illustrated; the seventh, relating to "eyes and other objects," also furnishes materials for an instructive plate, and shows how the optical apparatus of fishes, insects, and other accessible creatures, must be treated in order to display their elaborate provisions and adaptations to the conditions under which their owners live. The eighth chapter treats of "vegetable productions," the ninth of "organic remains, crystals, and artificial objects; the tenth and eleventh discourses of animalcules, and the twelfth concludes the work with an excellent little essay on "the circulation of the blood," and the various ways in which it may be pleasantly observed without injury or pain to the animal employed. The phenomena of circulation may be well shown in the young water newt, easily obtained from ponds in the spring. Mrs. Ward observes concerning it:—"The young smooth newt retains its external branchiæ to a much later period than is the case with the frog tadpole; although it would seem, from what I have observed, and also from Professor Bell's remarks on this subject, that there is a great variety in the period at which the branchiæ disappear in this species. I have, however, constantly met these young newts, when nearly two inches in length, still possessing those beautiful appendages; which, instead of being pale as at first, appear of a fine chestnut colour; but they have lost much of their transparency, and therefore for microscopic observation the newts answer best when of the size represented in the figure, and till they have grown to about twice that length. The great size of the corpuscles, as compared with the size of the animal, makes the object exceedingly striking. They are oval, like those of the frog, but larger, being (in round numbers) one eight-hundredth of an inch in length, while those of the frog are one eleven-hundredth; and both these are singularly large compared with those of man; these latter are but one three thousand two-hundredths of an inch in diameter."

Mrs. Ward also states that little newts are more tractable than frog tadpoles, and consequently easier to see; she likewise recounts how she once noticed the appearance of "a pink spot, apparently fading and re-appearing a number of times in a minute." This was the little creature's heart propelling its infant stream.

The specimens we have given will show the clearness of

Mrs. Ward's explanations, and the freshness imparted to her pages by their recounting genuine personal experiences—instead of the matter being, as is too often the case, borrowed at second-hand—will commend her work to every one into whose hands it may fall. The coloured plates, sixteen in number, are very artistic productions, and Mrs. Ward's labours, both with pencil and pen, will serve to encourage other ladies to a similar exercise of skill. Even where there is no idea of publication, a diary or journal should be kept of microscopic studies, and there are few families in which one or more of the number could not soon learn to draw well enough to illustrate it with effect. Work of various kinds necessarily occupies a large portion of the time of most members of society; but there is a great want of intelligent occupations, carried on with sufficient perseverance to become sources of permanent pleasure, and to have a wholesome influence on the mind. Microscopic pursuits can be so indefinitely varied as to suit a great variety of tastes; and, when a suitable instrument has been obtained, they involve little further cost. They should, therefore, be strongly encouraged, and it will not be found that, by so doing, anything like one-sidedness is created. On the contrary, different persons will take different fields, and all will find that a wide range of reading will be stimulated by the desire that must arise to gain information concerning the objects that are surveyed. Mrs. Ward's work will make its way into numberless homes, and all the more readily from its being an elegant present, for a sensible mother, or a convenient uncle, to give, and it may be read with the agreeable conviction that, though it is simple in form, it is strictly scientific in thought; and, by the fascination of its lucid style, it will induce many to become diligent students who would have been scared from the path of knowledge by a less accomplished and genial guide.

VANADIC ACID.

BY DR. PHIPSON, F.C.S., LONDON,

Late of the University of Bruxelles; Member of the Chemical Society of Paris, etc., etc.

It is now nearly sixty-three years since the observing world began to get glimpses of the metal Vanadium. In 1801, the mineralogist Del Rio, travelling in Mexico, met with a peculiar mineral in the lead mine of Zimapan, and announced that he had found in it a new metal, to which he proposed to give the name of *Erythronium*. This mineral, which, let it be stated immediately, was vanadate of lead (vanadinite), has been since met with in Dumfriesshire, at Wanlockhead, where it occurs as small globular masses, more or less crystalline, or as a thin coating, on Calamine; and also at Beresof, in the Urals, where it accompanies the mineral Pyromorphite. The Mexican specimens were reddish or yellow coloured, heavy, brittle, and fusible.

Del Rio analyzed this mineral, and assured himself that it contained an element then completely unknown. He sent specimens of it to Paris, where they were again analyzed by Collet Descotils, who declared that the new metal Erythronium was simply impure chrome, and, strange to relate, Del Rio adopted this opinion, and looked upon the newly-discovered mineral as a subchromate of lead.

It was not until twenty-nine years later, that Sefström of Stockholm discovered (1830) a new substance in Swedish iron, obtained from the iron ore of Taberg, not very far from Jungköping. This substance proved to be a metal, to which he gave the name of *Vanadium* (from Vanadis, a Scandinavian divinity, nearly forgotten by the northern poets of the present day). A little later, Professor Wöhler, of Gottingen, on examining specimens of Del Rio's mineral from Zimapan, found that it really contained, not chrome, but vanadium—that it was, in fact, vanadate of lead, and that Del Rio's first opinion, that it contained a new substance, was perfectly exact.

Not only the Swedish iron contained vanadium, but the iron slags or cinders, and the iron ore itself, were found to contain small quantities of *Vanadic acid* (the oxide or rust of the new metal). Berzélius and Sefström were the first to investigate thoroughly the properties of this curiously discovered substance. The metal is best extracted by passing a current of ammonia over chloride of vanadium heated in a glass bulb. It is a white metal, and, when polished, resembles silver. It

is not very ductile or malleable, and can be easily reduced to powder, like antimony, but is extremely difficult to melt.

This metal has not yet been applied to any useful purpose in the arts, but it is probable, or, rather, almost certain, that very small quantities of it in iron or other metals and alloys have a considerable influence upon their qualities. Three or four oxides of vanadium are known to exist, at least as laboratory products; one of them, vanadic acid, which will alone occupy our attention here, is the state in which vanadium has hitherto been found in nature. It is generally obtained as a pale-chocolate-coloured powder, almost completely insoluble in water, but soluble in alkalies, and fusible over a spirit-lamp. It shows a beautiful phenomenon whilst cooling, to which I have alluded in my work on Phosphorescence; when melted in a platinum crucible and allowed to cool slowly, it crystallizes, and emits at the same time a reddish phosphorescent light, during the whole time that the crystallization lasts. Several other mineral substances, and boracic acid in particular, exhibit the same curious emission of light when placed in similar circumstances.

Another remarkable property of vanadic acid, which leads us to imagine that this substance (so rare at the present day that scarcely any laboratory in London possesses a specimen) will be, some day or other, employed in the porcelain manufactories, is this: that when heated at the inner flame of the blow-pipe with borax, or with the double phosphate of soda and ammonia, it forms a beautiful green bead, a brilliant apple green, which it would be desirable to see produced upon porcelain.

The metal vanadium has been very little investigated, because the sources of vanadic acid have been found hitherto to be so extremely limited. Even the vanadate of lead discovered by Del Rio, which contains about 23 per cent., and similar minerals from Rhenish Bavaria and South America, giving 46 to 49 per cent. of vanadic acid (the Scotch specimens give 15 to 23 per cent.), are very rare; and the same remark applies to a vanadate of copper found occasionally in Transylvania and Thuringia, which contains 36 to 39 per cent. of the substance in question.

Vanadic acid has, however, been met with as an accidental constituent of several mineral substances, more or less plentiful, particularly in hydrated oxides of iron, in pitchblend (oxide of uranium), etc. We shall see, presently, the names of all those substances from which it has, up to the present day, been extracted.

In 1859, a young French chemist, M. Beauvallet, announced the existence of small quantities of vanadic acid in the clay

of Gentilly, near Paris, which is used to make the flower-pots for the Jardin des Plantes. It was in that year that Professor Pisani and myself procured some of these flower-pots, ground them down to a coarse powder, and extracted vanadic acid from them, but in very small quantities, for the process by which we operated (that recommended by Beauvallet) proved rather unsatisfactory. A little later, I submitted to the same investigation, in Pisani's laboratory, a variety of Belgian clays, from the neighbourhood of Ypres, Ostend, Lacken, etc.; and in 1860 and 1861, I made several new experiments on the extraction of vanadic acid from these substances, in my own laboratory in London. I examined particularly London clay and the gault of Sussex, also a peculiar hydrated oxide of iron from Saxony, which gave nearly two per cent. of vanadic acid, and some English iron-stones; and in 1863 I published in the *Journal of the Chemical Society* a short account of these researches. It was not known until then in what state vanadic acid exists in these iron-stones, clays, etc., but my analyses show that it is found as phosphate of vanadic acid, a compound described by Berzélius, and that the iron ores which contain much phosphoric acid are also those which yield most vanadic acid.

As the results of these analyses, I found that London clay contains from 0·023 to 0·056 per cent. of vanadic acid; the gault of Sussex yielded me 0·046 to 0·070 per cent.; the white clay of Ypres, in Belgium, 0·033 per cent.; an English iron ore (red hematite), containing much phosphoric acid, gave me as much as 0·40, and another 0·92 per cent. of vanadic acid. But the largest quantity was found in the iron-stone, which I have termed *vanadium ochre*, from Saxony, from which I extracted 1·60 to 1·90 per cent. In several other specimens of clays and iron-stone the presence of vanadium was put in evidence, but its quantity was not determined.

Other chemists have sought for vanadic acid in several mineral substances. A. Müller found 0·03 per cent. in an hydrated oxide of iron from Wittemburg; Fritsche found the enormous quantity of 1·78 per cent. in a German copper ore (Konichalcite), which doubtless contained some vanadate of copper, as well as arseniate and phosphate of copper detected by the author; Weibye found 0·22 per cent. of vanadic acid in a Norwegian schist (silicate of alumina), and Schrötter detected 0·37 per cent. in the iron slags of Verdenberg; whilst Kersten found 0·15 per cent. in some sulphide of iron slags, a small quantity also in the copper schist of Mansfeld; and H. Deville extracted as much as 0·32 per cent. from a specimen of rutile. Wöhler, Swanberg, and Ficinus have detected notable quantities of vanadic acid in the pitchblend of Germany and

Bavaria, but have not ascertained how much this mineral generally contains; neither did Sefström nor Schultz and Bodeman determine the quantity of vanadium present in the iron ores which they investigated. Deville likewise detected the presence of vanadic acid in bauxite, an aluminiferous mineral, from Baux, in the south of France, utilised in the manufacture of aluminium. The quantity of vanadic acid present in the flower-pots of the Jardin des Plantes was not determined. To allude to some substances which usually accompany vanadic acid in clays, I will mention that titanic acid and tantalic have been both found by myself and other chemists; also phosphoric acid is very usually present in small quantities.

One hundred parts of vanadium ochre gave me on analysis: water and a little organic matter, 12·60; oxide of iron, 57·50; alumina, 5·00; vanadic acid, 1·90; phosphoric acid, 2·20; titanic acid, traces; magnesia, 0·30; lime, 0·20; carbonic acid, 0·24; silica or quartz, 20·00 = 99·94.

Let us take 0·05 per cent. as the probable quantity of vanadic acid contained in the greater bulk of that vast geological deposit known as the London clay. At this rate one ton of London clay would contain about 1 lb. 2 oz. of vanadic acid, say 1 lb. to the ton in round numbers. If we suppose that there exists only about a million tons of this clay at the west end of London, for instance, in the Hyde Park and Bayswater districts alone, we have evidently there upwards of 445 tons of vanadic acid!

And if we calculate the quantity of vanadic acid which exists in the London clay of the metropolis, supposing London to cover fifty square miles, and taking the stratum of clay at the moderate thickness of four yards, we find that, under this city alone there lies probably far more than 303,443 tons, or about 679,712,320 lbs. weight of vanadic acid; the present price of this substance in shops where chemical curiosities are sold being about one shilling and sixpence per *grain*, or £32 5*s.* 6*d.* an ounce!

I have not the slightest doubt that all clays contain similar quantities of vanadic acid, and if it can be extracted with tolerable ease, both this substance and the metal it contains may sooner or later prove themselves new industrial agents in the hands of man. It remains only to discuss the most advantageous method of extracting vanadic acid, and it will be seen that the operation may be reduced to a very simple process:—

M. Beauvallet, M. Pisani, and myself began by boiling the baked clay of the flower-pots with three per cent. of its weight of carbonate of soda and a sufficient quantity of water. Finding that caustic soda, as recommended by H. Deville, appeared to answer better, I repeated the experiments with it in place of

the carbonate. The boiling must be continued for several hours, and even then the total extraction of the vanadic acid is not effected. The filtered liquid containing silica and alumina is neutralized with sulphuric acid, and then ammonia and sulphydrate of ammonia are added. The whole is left at rest for two hours to separate the silica and alumina; the filtered liquid contains sulpho-vanadate of ammonia, whence sulpho-vanadic acid is thrown down by excess of acetic acid and boiling. We can also separate vanadic acid by adding chloride of ammonium in excess, boiling, filtering, and adding to the filtered liquid a solution of tannin, which causes a blue precipitate, nearly black, containing all the vanadium contained in the liquid. M. Deville calcines the material from which vanadic acid is to be extracted with a little caustic soda, and then submits the whole to lixiviation. The filtered alkaline solution is saturated with sulphuretted hydrogen, which precipitates the silica and alumina, whilst the vanadic acid remains in solution as sulpho-vanadate of soda. In these cases the sulpho-vanadic acid is transformed into vanadic acid by roasting. These processes are somewhat tedious, and do not appear to yield all the vanadic acid present in the substance experimented on.

The method I prefer is simply a modification of Seftsröm's original process. It is applicable to any mineral substance, and gives very satisfactory results.

About half an ounce of the mineral (iron ore, clay, etc.), finely pulverized, is intimately mixed with half its weight of saltpetre, and the mixture heated to a dull red heat for fifteen or twenty minutes in a platinum crucible. The residue is treated with boiling water, to which a small fragment of caustic soda is added; it is then boiled for about a quarter of an hour, filtered, and the residue washed with boiling water. The liquid is *nearly* saturated with nitric acid, and precipitated by excess of chloride of barium; the precipitate is decomposed by sulphuric acid, the filtered liquid neutralized by ammonia, and saturated with chloride of ammonium. The whole of the vanadic acid present comes down as vanadate of ammonia in the course of two days. In some instances the process may be rendered more simple still; and for extracting vanadic acid on the large scale from iron ores, pitchblend, or from London clay, it will be sufficient to calcine a given quantity of these substances with one-fourth to one-half of their weight of a mixture of carbonate of soda and nitrate of potash; the calcination lasting about half an hour. The calcined mass is then boiled for some time with a little water, the liquid filtered, and supersaturated with chloride of ammonium. If the filtered liquid is too bulky it must be evaporated. All the vanadic acid is precipitated as vanadate of ammonia in the course of twenty-four

to forty-eight hours. This salt being collected and dried, is submitted to a careful calcination in an open crucible, the temperature being kept moderate. The vanadic acid thus produced has clear chocolate colour, and is nearly chemically pure.

In thus preparing vanadic acid on a large scale, care should be taken to employ chloride of ammonium as pure as possible. If this salt contains chloride of iron (as is frequently the case), the vanadic acid obtained will have a reddish colour, which is not observed in the pure acid.

In conclusion, I will add that Berzélius discovered that when vanadate of ammonia or vanadate of potash is added to a decoction of gall-nuts, a very good writing ink is produced, which may be said to be almost indelible; also, that I have found that vanadic acid cannot be detected in mineral substances by the ordinary blow-pipe test when a certain quantity of titanic acid is present.

UTILIZATION OF THE MAIZE PLANT.

At the Great Exhibition of 1862 specimens of paper manufactured from the Indian corn or maize plant were exhibited, and in our number for July, 1861, we mentioned that paper of this description was used in Austria for the books required in the primary schools. The present price of cotton is most likely destined before long to experience a great fall; but it is still for the good of society that fibres of other kinds hitherto neglected should be made available for the multifarious manufactures which civilization requires. It is also highly important, in this as in other directions, to utilize waste products, as the average condition of mankind cannot be materially improved so long as considerable sources of wealth and comfort are thrown away. Applied science is continually engaged in obtaining beautiful and valuable results from materials which ignorance pronounced to be good for nothing, or positively mischievous; and as necessity sharpens the inventive faculties, the dearth of cotton may, in the end, give rise to so many new manufactures and processes as to take its place amongst those numerous instances of a temporary evil evolving a large amount of permanent good.

Dr. Forbes Royle long ago pointed out a vast quantity of Indian fibre producing plants which were not utilized; but neither he nor any other scientific inquirers ever directed attention to the capacities of a vegetable body which appears better worth attention, than what is called, the refuse of the maize. Over large tracts of country in America, in Italy, in Hungary,

and elsewhere, Indian corn or maize constitutes the chief food of the population, and is produced in such abundance that the leaves and stalks can be obtained in immense quantities and at a low price. Attempts to utilize these portions of the maize plant are not altogether new, but Dr. Alois Ritter Auer von Welsbach comes before the public with what appears to be a complete scheme, and he has taken out patents for his inventions in the chief countries of the world. In a paper before us, he divides the products of maize refuse into three classes—fibrous, nutritious, and paper-pulp. He extracts from the leaves of the plant an organic substance, which he tells us resists putrefaction, and which we therefore conclude cannot be rich in the nitrogenous matters that constitute the chief value of the better kinds of food. It may, however, be good, as we are informed, to mix with flour, and it is stated to keep bread from getting, what is termed, dry—a condition which is more dependent upon molecular changes than upon actual loss of water by evaporation. We have not had an opportunity of seeing or tasting this material, but through the kindness of Martin Diosy, Esq., the Hungarian wine-merchant, in Fenchurch Street, we have received samples of the other articles which Dr. Welsbach's process affords. First, we have a handful of fibre like fine hemp; next, the same fibre spun into threads; thirdly, the threads woven into a strong coarse brown linen cloth, like fine sacking; fourthly, a strong, partially bleached cloth, of good whitey-brown colour, even texture, and considerable strength; fifthly, sixthly, and seventhly, we have finer and whiter qualities of the same kind of cloth, which the ladies of the household pronounce capable of being used for a variety of domestic purposes. After these, we find pulp for paper making, bleached and unbleached, and then comes a very interesting collection of paper of various kinds, some stiff and suited for drawing, some exquisitely transparent and firm, for tracing, others for writing and printing, some in the curious condition of parchment-paper, and others again delicate in texture, and of various ornamental tints.

It is no business of ours to go into commercial details; those who need them may be referred to M. Diosy or Dr. Welsbach; we look at the matter merely in a scientific and technological point of view, and regard the series of products before us as a very interesting illustration of how many useful things may be made out of a neglected portion of the vegetable world.

The result of operations carried on at the Austrian Government mills, near Vienna, is reported to show that three to three and a-half hundred weight of maize leaves yield forty pounds of thread, sixty pounds of paper-pulp and thirty of flour. We have no details of the process of manufacture, but it is stated to be exceedingly simple. The economical value of the plan depends upon

a variety of considerations; but where the maize is extensively grown, and there are local facilities for manufacture and transport, it would seem well worth the consideration of practical men. As the seed of the plant sells for sufficient to give a profit on the cost of cultivation in suitable localities, and as three useful substances, amounting in the aggregate to 130 lbs. out of three hundred weight of leaves, can be extracted, there is ground to hope that the process may pay. The pecuniary consideration is, however, foreign to our objects, and if we had fully studied them, we should decline offering an opinion. All that belongs to us to say, is, that Dr. Welsbach has displayed considerable technological skill in producing the series of objects that have been sent for our examination, and we hope his labours will be of value in creating a new branch of industry, and augmenting the supply of materials in daily and increasing demand.

FURTHER NOTE ON THE COAL SUPPLY.

BY PROFESSOR ANSTED, F.R.S.

MY attention has been drawn to an error more unaccountable than really important, in reference to the argument in my article on the "Supply and Waste of Coal," in your last number. I have said, in page 322, that an acre of land contains 2840 square yards. I need not remark that the real figure is 4840; but what was originally, probably, a slip of the pen, I have inadvertently carried out in a little calculation with reference to the quantity of coal in each square mile, one foot thick; and again in the estimated grand total of coal under certain probabilities (p. 323), and the available remainder, in page 325. I can no more account for the error than in the case of a mistaken date; but the reader may observe that the value of the argument is really unaffected. I had no intention to do more than give a general illustration, and it matters little whether the actual quantity of coal left is estimated at thirty-five or sixty-five thousands of millions of tons, the present consumption being a hundred millions, and rapidly increasing.

The figures should be as follows:—

Each square mile of coal, one foot thick, contains 968,000 tons, and if the mean thickness is fifty feet, and the area 6000 square miles, the quantity is 290,400 millions of tons. The fourth part of this available is 72,600 millions, and the remainder 65,000 millions. This would be exhausted in a few centuries, under the supposed conditions, and economy is therefore loudly called for.

I must apologise to your readers for an error that certainly ought not to have been allowed, but of which I can give no account.

PLATEAU'S ARITHMETICAL PROBLEM—A NEW METHOD.

BY JAMES J. HOOTON.

I HAVE just read in this month's number of the INTELLECTUAL OBSERVER a translation of a paper communicated by M. Plateau to the Belgian Academy, in which that gentleman supplies a general rule for the solution of a certain problem involving the properties of numbers. It occurs to me that a more direct method of dealing with this simple matter would be to assume $N = \frac{11111\ldots\ldots}{n}$ where N is the required multiplicand, n the given multiplier, and 11111 . . . . ., a number containing the smallest iterating figure, of which any other similar number would, of course, be a multiple. Adopting this equation, it will be found by experiment that for even values or multiples of 5 given to n, the quotient of 1111 . . . . $\div$ n or N will be a number with a figure or figures recurring, *ad infinitum*, and that, consequently, the problem fails for all such values of the independent variable (n). For all other values of n, the quotient is terminable, and we arrive at one result without the aid of "periodic decimal fractions," etc.

THE MELOPHAGUS, OR SHEEP-TICK.

BY L. LANE CLARKE.

(*With a Tinted Plate.*)

WHEN the farmer, careful for the well-being of his flock, gives the order for a sheep-washing, or "a ticking"—and thousands perish of the parasites which irritate the sheep—doubtless the farmer is right; we have dominion over "the creeping thing," and reason to judge of its proper rate of increase. Nevertheless, that same sheep-tick presents an interesting and thoughtful object for a naturalist, who, entering into the mysteries of organic life, gathers up every minute variation and modification, holding each as a clue to guide him through the labyrinth of Almighty wisdom, which the mere classification of genera and species fails to grasp.

Comprised within the order Diptera, or two-winged flies, we find several genera which have no wings at all: the apterous and suctorial Pulex, and the apterous and pupiparous Eproboscidæ; though amongst these latter we have the winged Hippobosca, or horse-fly, the Ornithomyia, or bird-fly, and the Stenopteryx, or swallow-fly.

The Melophagus (Fig. I.) is apterous, and possesses some remarkable links with insects of both higher and lower organization. It is easy to procure, and makes a good object, also for the microscope, if soaked in potash, washed, dried, and mounted in balsam, when it polarizes brilliantly. For present examination we need but use a low power, and look at it as an opaque object, observing that the coriaceous, bristly body is divided as usual into three distinct parts—head, thorax, abdomen; but that, unlike the rest of the Muscidæ, the abdomen has no segments, because the system of reproduction, differing entirely from the oviparous or viviparous flies, requires an elasticity and firmness in that part which could only be obtained in a perfectly continuous substance; yet, when the female has expelled the pupa-form of her progeny, there is found, *more* or *less*, in the Hippobosca, Ornithomyia, and Stenopteryx, transverse plaits or folds of the abdomen answering perfectly to the segmentation of a dipterous abdomen, but fading quite away in the Melophagus.

We may also notice the comparatively few facets in the eye of this sheep-tick, which needs no more for its sedentary life amidst the dark mazes of the matted wool; a highly reticulated eye, like that of its nearest relative, the Hippobosca, who darts about in the sunshine, would be wasted here.

The position and strength of its legs we observe as exactly adapted for pushing through the woolly thicket, with claws like harpoons, toothed and striated (Fig. VIII.), clinging so desperately to the sheep that desperate measures are needed to relieve the animal of its parasite. These are only well seen in the mounted specimen, and so also must we prepare the insect to see the perfection of its suctorial apparatus. This is composed of a pair of hairy valves protecting a very slender siphuncle, rigid and sharp, and may be compared with that of the horse-fly, which is shorter, because exercised upon the nearly naked skin of the horse, whereas the Melophagus requires a long, flexible dart, in searching for a vulnerable point amidst the clotted wool.

The next point of interest will be the number, position, and variation of its spiracles.

It has nine pair of these breathing organs—two pair in the thorax, seven in the abdomen (Fig. III.)—round in form, and edged with simple cilia, quite unlike the spiracles of the Muscidæ; for as this insect passes its life in the suffocating atmosphere of a woolly back, it wanted every facility for inhaling the necessary oxygen, and therefore has many more spiracles, and of much less complicated form than the house-fly and its brethren. These circular spiracles dilate and contract, the cilia shorten by a muscular contraction at their base, and leave a perfectly open space. (Fig. III. *a.*)

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[illegible] comparatively few [illegible] no more for its [illegible] ted wool; a [illegible] the Hippobosca [illegible] wasted here.

[illegible] its legs we observe [illegible] the wool's thicket, with [illegible] and serrated (Fig. VIII.), clinging [illegible] measures are needed [illegible] These are only well seen [illegible] so also must we prepare the [illegible] suctorial apparatus. This is [illegible] very slender [illegible] compared with that [illegible] exercised upon the [illegible] Melophagus requires [illegible] vulnerable point [illegible]

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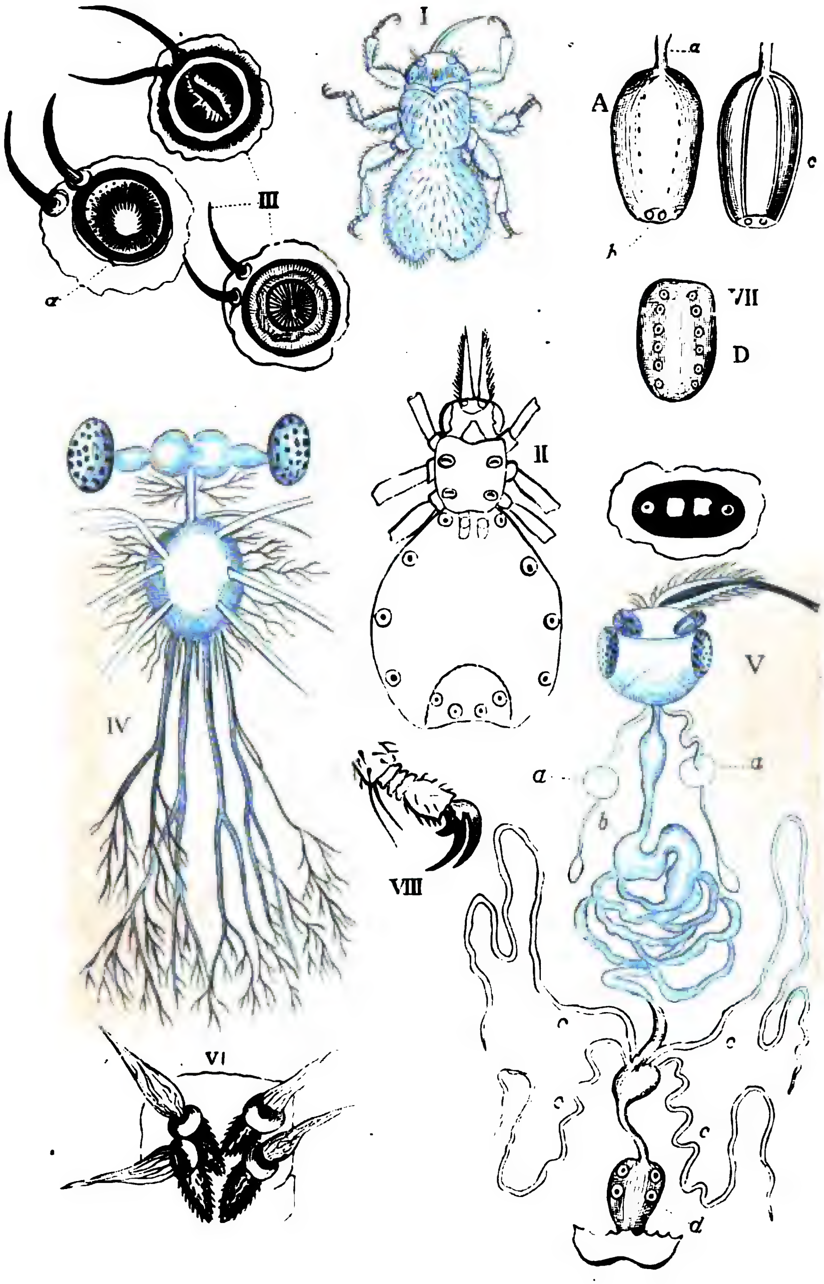
It [illegible] breathing organs—two pa[illegible] (Fig. [illegible]) — round [illegible] the spiracles of [illegible] in the suffocation [illegible] very facility for [illegible] many more spiracles [illegible] form than the house-fly and [illegible] tract, the cilia [illegible] their base, and leave a perfect [illegible] (Fig. III. a)



Melophagus, or Sheep Tick.

Having briefly noticed the external structure of the Melophagus, we shall be inclined to take a fresh specimen and examine its internal anatomy; a little patient dissection will give us two very interesting observations. First, with regard to the alimentary canal (Fig. V). Opening the Melophagus with dissecting scissors under water, the whole will float out, and show the œsophagus, the convolutions of the intestine, the salivary glands, hepatic vessels, and some internal appendages, which, with a higher power, we must now observe.

This requires nice management of the dissecting needles to open the enlarged part of the rectum, on which are four small dots called by Dufour "*Les boutons charnus.*" They mark the position of four internal papillæ found in most of the Diptera, but with a modification in the Melophagus. They are slightly mentioned by Owen in his Lectures on Comparative Anatomy, but no observation is particularly made of the Melophagus, in which the papillæ instead of being smooth are covered with short spines. (Fig. VI.)

These singular organs are supplied with a branch of tracheal vessels and strong muscles; they evidently work freely in the interior of the rectum, and assist in the expulsion of fœcal matter. Probably, as the Melophagus is eminently sedentary in its habits, these additional spines act as whisks and brooms to clear the way where the muscular contractions are less powerful and frequent; or they may act as rakes and sieves to separate the passing atoms and assist in the function of absorption.

The next point of interest is the very remarkable system of reproduction, whereby these pupivarous flies are separated in rank from all the other Diptera. They are neither oviparous or viviparous.

The female nourishes a single egg within her body, attached to her by an *umbilical cord*, which egg, in its early stage, possesses two small spiracles situated at its base (Fig. VII. *b*), by which air is conveyed to the pulpy substance within, from an *open* aperture in the abdomen of its mother. As the pupa progresses, eighteen spiracles develope on the surface of the skin, small dots covered apparently with a transparent membrane until the hour of its expulsion, when each tiny window flies open, and the innumerable coils of trachea expand and contract under the rush of life-giving air.

The pupa case is brown and hard, lies loosely amongst the wool; the shepherds call them "eggs," but they are really the protecting case of a young Melophagus. At the anterior end of the pupa is a slightly marked seam, indicating the aperture by which the fly will come forth. In the Melophagus, as in the common dung-fly (Scatophaga), I observe a very distinct *ptili-*

num, which is a soft, elastic membrane, the insect is able to inflate, and wherewith it pushes open the lid of its pupa-case; moreover, the abdomen has something of the same kind, probably to push against its case, and further assist its exit.

From these few observations I think we may look with interest, if not with admiration, on the common sheep-tick, and as a whole mounted insect, it is both easy to prepare and very satisfactory as an object for the polariscope, or for study of the legs, spiracles, and suctorial apparatus.

Explanation of the Plate.—Fig. I. Melophagus, or Sheep-tick. Fig. II. Outline of Melophagus to show the position of the spiracles. Fig. III. Spiracles, open and closed. Fig. IV. The nervous system of Melophagus. Fig. V. Digestive organs: *a*, Salivary glands; *b*, Alimentary canal; *c*, Hepatic ducts; *d*, *Boutons charnus* on the rectum. Fig. VI. Internal papillæ, with the tracheal vessels exposed. Fig. VII. Fœtus, with umbilical cord (*a*); *b*, anal spiracles; *c*, front view of the same; *d*, Pupa as found in the wool of the sheep. Fig. VIII. The tarsi and claws of Melophagus.

JEWISH SHEKELS AND OTHER COINS OF ANCIENT JUDEA.

BY H. NOEL HUMPHREYS.

(*Second Article.*)

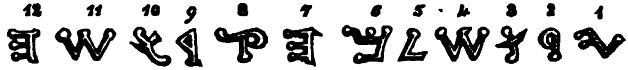
My paper on Jewish shekels, which appeared in the December No. (xxiii.) of the Intellectual Observer has brought me several communications on the subject, some requesting further information on certain details connected with this interesting subject, others suggesting a different assignation of particular coins, others only critical as to a misprint or two of the modern Hebrew characters. One correspondent asks why, in the deciphered inscription of a shekel of Yaddous (taking for granted the attribution of M. de Saulcy), of the second year, the Hebrew *i* should be omitted, as it appears on the specimen engraved in the plate. In answer to this question I may state that my interpretation was that of the inscription of a coin, now before me, in which the letter in question does not occur. I have been induced to consider it as a blunder of the engraver, seeing that a good and sufficient meaning has not been suggested for it. Some numismatists have thought that it expressed the *dual* form, in allusion to the second year; others, again, assuming the coin to belong to Simon Maccabæus, pretend that the *dual* form was intended to have refer-

ence to two distinct portions of the city, one superior to the other—the latter not being fully in possession of Simon Maccabæus till the second year of his issue of coined money; but this is an improbable straining after a meaning which cannot, I think, be accepted. I would rather accept it as an expression of the genitive, which would have more plausibility, as being in accordance with the usual Greek form of numismatic inscriptions. This, however, I think is also inadmissible. I have, therefore, taken the inscription as it stands on the shekels of the first year, without the *Iod*, and supplied the ה (*heh*), which is omitted in the inscription of coins of the first year. There are many difficulties connected with the interpretation of monetary inscriptions in the ancient Hebrew characters, commonly, but incorrectly, termed Samaritan. This old form of character had long been disused except for certain monumental purposes, and, from its infrequent adoption, it is not unlikely that blunders were sometimes made by mechanical engravers, just such as we find on our own mediæval coinage.* More especially so at a time when the old letters were very suddenly called into more general use for the first Judaic coinage, to which it was thus sought to impart a national character. That such a revival of the ancient alphabet should have been adopted for such a purpose appears natural, when it is considered that the style of the *square* Hebrew (as it is termed) was formed during the captivity, and therefore bore the stamp, as it were, of the slavery (as having been acquired in Assyria. It was sometimes called Assurith) from which the nation had just been rescued by the ruin of its oppressors consequent upon the Asiatic conquests of Alexander. Among the difficulties which occur in interpreting inscriptions in these characters, as used by engravers who but imperfectly understood their value, is the following, which has not, that I am aware, been noticed by numismatists:—I have often doubted whether the aspirate *heh*, as a definite and separate character, existed in the most ancient form of that alphabet. Consequently it is not easy to decide whether the character represented (in the deciphered inscription at page 332 of the last December part of this publication) by the English equivalents 12 and 13, and 21 and 22, be a *heh*, followed by a non-written vowel a (א), or whether it be a form of the old Hebrew א carrying with it its own aspirate. The form of the character is very like the ancient form of aleph reversed and set upright, as for

* Even in the Jewish series many obvious blunders of the engraver occur—for instance, on a coin of Herod the Great we find HR, the Latin R having been erroneously substituted for the Greek, and as in the coin struck on the reduction of Jerusalem to the form of a Roman colony, the word Capitolina is spelt KAPITOLINA, with a Greek Kappa.

a special purpose. Of such methods of changing the value of a particular letter we are not without examples. For instance, when, as on the most ancient incused coins of Sybaris, the Greek sigma, is written *flatwise*, thus M, it has been thought probable that, in that position, it represented the broad SH sound of the Hebrew and Phœnician character from which it was derived; while, in its subsequent upright form, it represented the sharper sound of the clear Greek sigma (Σ). Again, *initial* and *terminal* letters in the more ancient systems of writing had generally a special value. The Greek *eta*, for instance, at the beginning of a word, represented an aspirate, as in HXATON, while, in the middle of a word, it was used as a long *e*. It was the custom, in Oriental systems of writing (in which, as it is well known, the vowels in the body of words were omitted), to express them when at the *beginning* or *end* of a word; of which many curious examples might be cited in the Egyptian system. I have thus been induced to consider the character in question rather in the light of an aspirated aleph, being the old character changed in its position, like the Greek sigma, to give it the sharper value. Having taken that view in my paper of last month, I now supply another notation of the interpretation in which the more commonly accepted value of the character is given, which, being read from right to left, gives Jeroushalem Hakedoushah (Jerusalem the holy).*

12 11 10 9 8 7 6 5 · 4 3 2 1



י ר ו ש ל ב ה ק ד ו ש ה

H(a)HS UO D(e)K(a)H M(e)L(a)HS UO R(e) I

With regard to the types or devices of this interesting series of coins (namely, the first shekels attributed to the high priest Yaddous), a correspondent, wishing for information, asks if they are all alike. On the contrary, there are several varieties, and numismatists are not agreed as to the precise import of some of the devices used, not even of the two most common ones which I selected as the most interesting. The vase which I have called the *Omer* of manna—an interpretation which the

* In comparing this inscription with that of the article in the December Number, the reader must correct the errors of the printer in setting up the modern Hebrew letters appended to that inscription. At No. 1 there should be י (yod); at Nos. 4 and 5, and also at Nos. 17 and 18, there should be ו (vau). Similar errors occur in page 341, line thirty, where כ (caph) and ר (reech) should replace ב (beth) and ד (daleth).

passages cited, and many other reasons, render the most probable—is considered by Cavedoni to be the sacred vase which was used to contain the wine prepared as an offering to Jehovah, while the small pellets sometimes placed at each side of the vase are fancifully supposed by some to represent the loaves which were placed on the table of proposition. Their small size, however, renders this interpretation open to objection. The type which has long been considered as "Aaron's rod" is considered by several eminent numismatists, M.M. Longperier and De Saulcy among the number, to be the same object as the triple flower represented in the hands of the pontiffs on the bas-reliefs of Nineveh. If this be so, and that symbol be accepted as a priestly badge or ensign, the issue of these shekels under immediate priestly authority, in a state governed by a pure theocracy, is further authenticated, and their assignation to the priesthood of Yaddous appears the more probable. Dr. Levy, however, a German numismatist, has proposed to return to the old system, and reassigns the coins in question to the epoch of the Maccabees. The style of the workmanship of these coins, however, does not at all accord with the already debased style of the neighbouring Syriac coinage at that period, while it very closely resembles that of the earlier Greek period of Alexander, and still more closely that of the Persian satraps of Tarsus of the same epoch; rendering the theory of M. de Saulcy, on the whole, the most probable in the present state of our knowledge.

The copper pieces of the fourth year have as types, in addition to the sacred vase, the *loulab,* or bunch of green leaves that was carried in the right hand to the temple on the festival of the Tabernacles, and also the cedar-cone which was carried in the other hand.* The large pieces have also a date-tree, with fruit, which was evidently a national symbol; that emblem, as well as the cedar-cone and the loulab, being adopted by Barcocebas on the coins which he issued during the last revolt in the reign of Hadrian.†

In reply to the correspondent who wishes for illustrations of the coinage of Herod, especially a piece bearing the eagle type, suggesting that the appearance of the eagle on that coinage has an interesting historical significance, my answer must be want of space, both for that and several other matters of interest omitted with regret. I however disagree with my correspondent as to the *kind* of interest which attaches to the coins of Herod of the eagle type. He states, which I believe is also the opinion of a very eminent numismatist, that the eagle was placed by Herod on the coinage as a sort of defiance to the

* See Leviticus xxxiii. 40.

† See the paper, "Jewish Shekels," in the December Number.

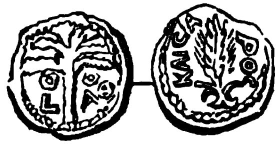
people of Jerusalem, who had torn down and destroyed a golden eagle which he had placed over the chief entrance to the temple; the introduction of such a form being considered idolatrous, and opposed to the ancient principles of Jewish law. My explanation of that type would be, that as on the coinage of the Asmonean or Maccabæan line of princes the types of the anchor and the cornucopiæ (which were symbols belonging to the Syrian princes of the Selucidæan dynasty) were adopted to express a friendly alliance with the sovereign of Syria; so the eagle (the emblem of Roman power) was used as a monetary type by Herod, the Idumean usurper, to denote his close alliance with Rome, without which he would have been unable to sustain his usurpation of the right of the legitimate princes of the Asmonean line. The same correspondent asks if I can explain the tripod type on the coins of Herod. I presume he alludes to the one engraved below. It is a burning altar, and is supposed to have reference to the re-consecration of the Temple after its splendid restoration in the fifteenth year of his reign. This view is not borne out by the date, year 3, though the coins appear to be of that epoch.

I may observe here that the two sons of Herod, Archelaus and Antipas, preserved the name of their father Herod; and Antipas, who was denied the title of king by the Roman Senate (or, more strictly speaking, the Roman emperor), but received the title and powers of Ethnarch of Judæa—placed no other name upon his coins than that of Herod, represented by the initial letters of the name in Greek, as HPΩ, and his title of Ethnarch abbreviated as EΘN.

It should be stated, as a learned French numismatist has observed, "Que le dernier mot n'as pas été dit sur la numismatique Judaique." Indeed, the question is far from settled. M. Lenormant, M. Longperier, M. Vogüé, and many others, are for removing most of the coins formerly attributed to the first, second, third, and fourth years of the Maccabæan dynasty, to an earlier period; while Dr. Levy and others have since declared for reinstating them. The question at issue is by no means decided. "The last word has not yet been said." It is at all events sufficiently clear that coins bearing the impress of workmanship of evidently distinct epochs of art, cannot be classed together as belonging to one historical period. In the mean time, I have endeavoured to give such a general view of the subject, from its earliest treatment by modern numismatists,

as may enable the general public to follow and appreciate the new views on the subject which are from time to time appearing; especially the logical and very complete theory of M. de Saulcy, from which, however, I have ventured to differ in some particulars.

Among other remarks of my correspondents on the subject, it has been suggested that the date on the coins issued under the auspices of the first Roman Procurators of Judæa is that of the era of Augustus, and *not* that of the battle of Actium. I think it probable that it may be so, but the dates only differ by three or four years, and I have therefore thought fit at present to follow the great authority of Eckhel, who calls it the Actian era. Cavedoni, another very good authority, considers it to be the Alexandrian era; while both the Actian and Alexandrian eras bear reference to the first establishment of the power of Augustus throughout the eastern possessions of Rome. The coin engraved below is one of the coins in question, bearing date the 39th year, ΓΘ, which was misprinted in the former article.*



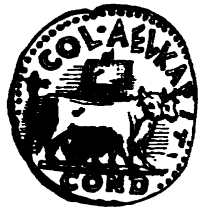
The same correspondent observes that the inscription ΒΑΣΙΛΕΩΣ ΑΓΡΙΠΠΑ should be ΒΑΣΙΛΕΩ ΑΓΡΙΠΑ, with one Π. He is not aware, it would seem, that the inscription occurs in both forms, as D. Cavedoni expressly states. My correspondent further suggests that the coins with this inscription all belong to Agrippa I. D. Cavedoni, on the other hand, gives them all to Agrippa II., and says nothing of coins belonging to Agrippa I.

Another remark I have to reply to is, that, according to my correspondent, the Emperor Titus, in the coins of the celebrated JVDAEA CAPTA type, places his foot upon a helmet, and not upon a clod of earth, as I have stated. It is true that in many of the devices of that class it is so; but they vary very considerably, even in the more important features. Many which I have examined have the object on which the emperor places his foot of such irregular shape, that it is impossible to trace the form of a helmet by the utmost stretch of imagination. I have, therefore, in describing the coin before me, presumed it to be a clod of earth, seeing that in other Roman devices of a similar class a figure seated on a small mass of rock is intended to symbolize a taking possession of territory.

Errata for the December Number, 1863.—In the interpretation of the inscription at page 332, the Hebrew letter at No. 1 should be י (yod), instead of ז (zain), and at Nos. 4 and 5, and 17 and 18 there should be ו (vau) instead of י (yod); at page 341, line 30, ב (beth), and ד (daleth), should be respectively כ (caph) and ר (resch); at page 338, line 35, for ΠΡΩ read ΗΡΩ; at page 340, for ΒΑΕΙΛΕΩΕ read ΒΑΣΙΛΕΩΣ; at page 318, read Λ. ΓΘ (year 39).

* The Λ. ΓΘ is very indistinct, and the Λ of ancient form.

The coin engraved below is one of those struck on the occasion of the final suppression of Jewish independence, in the reign of Hadrian, after the revolt of Barcocebas. It bears the name of the colony, abbreviated, which in full would be COLONIA AELIA CAPITOLINA: beneath, in the exergue, are the letters COND, being an abbreviation of the word CONDITA (founded). The type is the old colonial one of the Romans, the two bullocks at plough, in allusion to an ancient and primitive Roman custom of attaching as much land to a colony as two bullocks could encircle with a furrow in a single day. The standard behind the bullocks intimates that the colony is a military one. The obverse of this coin has the head of the emperor, laureated, with his name and titles.



CLUSTERS AND NEBULÆ.—OCCULTATIONS.—THE ACHROMATIC TELESCOPE.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

CLUSTERS AND NEBULÆ.

We shall have little trouble in recognizing the next object if the telescope is competent to show it. It is by no means remarkable in itself, but, should the suspicions entertained concerning it be verified, it will prove one of the most curious objects in the heavens.

6. *The Nebula in the Pleiades.*—1859, October 19. Tempel at Venice discovered with a small instrument a previously undescribed nebula close to the star *Merope* in that group, which he says was large and bright, and twinkling in places, similar to a beautiful bright comet.—1860, December. Peters and Pape at Altona, in tolerably favourable weather, could only perceive it with difficulty in a 6-feet telescope.—1862, Aug. D'Arrest and Schjellerup, with the new great Copenhagen refractor, of about 11 inches aperture and 16 feet focus, could not find it in nights when a nebula called "extremely faint" by H̥ and "excessively faint" by H was not only easily distinguished, but seen double. Such an apparent change in connection with the fact that a similar and contemporaneous decrease of light had been noticed in two other nebulæ in the same region, of course excited great interest. Familiar as observers have become with the marvellous phenomenon of variable brightness in stars, the evidence of which is rapidly accumulating with each succeeding

year, there is something in the idea of a simultaneous variation in a whole assemblage of stars, as we have already pointed out in the case of the nebula in Orion, which seems to pass the bounds of probability, and inclines us rather to the alternative of luminous mist. The question, however, as to whether this nebula—so curiously situated among the Pleiades—is actually variable, can hardly be considered as decided, notwithstanding the evidence which has been adduced. Schmidt, the present director of the observatory at Athens, is strong on the affirmative side. He states that he has been in the habit of watching the Pleiades more or less since 1841, and commenced drawing them in 1844, and that between that date and 1860 he had observed them on thirty-two nights; his comparisons of brightness, several hundred in number, being intermitted only in 1846 and 1859; but that during all this time he had never seen the nebula. He thinks it could not have escaped him had it been visible in 1861 with a 4-feet Dollond; February 5th in that year he saw it for the first time with the refractor at Athens (probably a Dialyte by Plössl, of 7½ [French ?] inches aperture; but not, as it seems, of the highest quality). The air being quite clear, it appeared very large, very pale, and quite shapeless, *Merope* lying in its N. corner, so as to appear a nebulous star in comparison with its brilliant neighbours. Between this date and the end of 1861 he saw it two or three times.—1862, March 26th, he finds "the great triangular nebula in the Pleiades easily visible; its extension towards the west is, however, much greater than I had previously believed." On the other hand, Schönfeld at Mannheim doubts the fact of variation. He saw it, 1862, September 20th, not fainter than in 1860, as Chacornac had done at Paris two nights previously; and he thinks that this and the other suspected nebulæ, being very feeble, large, and diffused, are influenced in visibility by magnifying power, varying transparency of air, and practice of the eye, so that aperture is less concerned in their case than in that of minute stars. Auwers, of Göttingen, argues on the same side. It has often, this observer says, been remarked—Encke's comet being an instance of it—that large, ill-defined, faint objects are best seen with small instruments, and that probably this nebula, having 15′ of extent, filled D'Arrest's field under a considerable magnifier, and so became inconspicuous; he found it an easy object in a comet-finder of 2 feet focus, and saw it repeatedly;—1860, September 23rd and 24th, when only 16° high; 1861, January 14th; 1862, February 19th and 21st. From its size it can be distinguished with only twenty-one lines of aperture (1¾ French inches).—Winnecke, again, the assistant at Poulkowa, saw it with 4 French inches in March, 1862, large and ill-defined, yet easily visible, as it was also in a

comet-finder; on the contrary, the director, Otto Struve, could only satisfy himself that it was perceptible in the great achromatic of $14\frac{9}{10}$ inches with a power of 150, by moving the tube to and fro.—1862, September 29th, it was very easily visible at Poulkowa with two smaller instruments, and even the comet-finder of about three inches aperture, which also shows some nebulæ considered to be very faint; extent being, in such cases, according to Winnecke, the condition of visibility—a conclusion which we have certainly seen borne out in the instance of No. 4 of our present list.

These details, which, under other circumstances, might be thought tedious, appear admissible in an inquiry, the result of which may prove of very great interest; and whichever side may ultimately prove to be right, the object is certainly curious enough to deserve a search. I was thus employed a little before the earthquake in the early morning of October 6; when, as I had so far lost sight of the foregoing particulars, that the utmost of my recollection was that of a large faint triangular object, including in one corner one of the brighter Pleiades, my result, if any, was likely to be tolerably unbiassed. On turning the telescope upon the group with powers of 29 and 64, though I probably should not have discovered it unknown, I found it with ease, as a very ill-defined, but on the whole egg-shaped haze, encompassing a brilliant star with its smaller but rather brighter end. A defective comparison with a diagram frustrated the identification of the spot on the following day; but on reviewing it, November 10, I found immediately that the star was *Merope*, and the glow connected with it the nebula in question. Students who wish to find it have only to point the telescope, with a low power, to *Alcyone*, the *lucida* of the Pleiades, readily distinguished by its beautiful appendage of a triangle of little sparkling gems; then *Merope* will be the next bright star *s p*, and the nebula will be seen encompassing it, and stretching away in feeble and diffused light towards the *s*, a little *p*, its greatest extent being, from a comparison with the field of my comet eye-piece, about 17′, or nearly the distance between *Merope* and *Alcyone*. Obscure as this object is, it may possibly prove a most important witness as to the existence of luminous matter in an unconcentrated form. It does not, however, stand alone, or the inference, from such disputed grounds, might appear very inconclusive. Two other similar instances, as we have observed, are suspected, and, strangely enough, in the same region; the best authenticated being at 9° distance, nearly in the direction of Aldebaran. The student, though he would now look in vain for this mysterious nebula, may be glad to see its data, as given by D'Arrest and Auwers. 1852, October 11, discovered by Hind,

faint and small, with a 7-inch object glass; 1854, seen by Chacornac at Marseilles; 1855, November, December; 1856, January, easily distinguished, even in moonlight, at Leipzig, with a 6-feet telescope; 1855, 1856, observed by Breen, with the Northumberland telescope at Cambridge; 1858, February, March, seen faintly at Göttingen with 6-feet achromatic; 1861, Königsberg, 8-feet heliometer, October 4, traces conjectured; November 3, in remarkably clear air, not a vestige of it, nor had it been seen there up to 1862, April 2; 1861, October 3, invisible in the great Copenhagen achromatic; 1862, January, sought in vain with the great Foucault silver-on-glass reflector at Paris, 27 inches in diameter, as well as by Hind and Secchi. Nor was Lassell able to perceive it, even with 48 inches of metal, in the pure sky of Malta; the Poulkowa achromatic alone continuing to show some feeble appearance of it in 1861 and 1862. This is marvellous enough, but the wonder is increased by the fact that a small star, only 1′ distant from it, has sunk, between 1852 and 1862, from 9·4 to 13 or 14 mag. The coincidence, to say the least of it, is sufficiently strange to arrest our watchful attention, especially in connection with Otto Struve's views as to the probability of variable light, not only in certain parts of the nebula in Orion, but in some of the minute stars involved in its extent.

7. *The Crab Nebula.*—In the directions for finding No. 75 of our Double Star List (INTELLECTUAL OBSERVER, Feb. 1863, p. 55), the position of ζ *Tauri* is pointed out: this star will readily guide us to a nebula lying rather less than 1° *n p*, which, though inconspicuous in itself, has become well known from the commonest of its portraits. It is No. 1 of Messier's list, having been discovered by him in 1758. He was observing the position of a comet near ζ *Tauri*, when he perceived it as "a whitish light, elongated like the flame of a taper;" and was thus induced to undertake his useful Catalogue. Smyth remarks that it "was also a mare's nest to more than one astronomical tyro in August, 1835, when on the look-out for the return of Halley's comet." The Admiral describes it as a large, oval, pearly-white nebula, brightest towards the S. In Sir J. Herschel's Catalogue, where it stands 357, it is stated to be 4′ long, 3′ broad; very gradually a little brighter in the middle, and resolvable. But a grand change was wrought in its aspect by the three-feet speculum, which was the earlier fruit of the Earl of Rosse's labours; he observes that "it is no longer an oval, resolvable nebula: we see resolvable filaments, singularly disposed, springing principally from its southern extremity, and not, as is usual, in clusters, irregularly in all directions . . . . . it is studded with stars, mixed however with a nebulosity, probably consisting of stars too minute to be recognized." I have

not met with any subsequent report of the action of the six-feet mirrors upon it. Its common name is derived from the branching filaments, in which some resemblance may be fancied to the claws of a crab; but the student must be content to trace it in the engravings which are often met with, as no ordinary instrument will touch these appendages, and they were not remarked even by Sir J. Herschel. With a small aperture it will be found a feeble object, though very distinguishable from its magnitude; with my 5¼ inches I thought I could see a mottled character pointing to resolution, and its edges, being known to be actually fringed, were suspected to look so.

A short distance from ζ, *p*, a little *n*, we shall find a pretty little open double star.

Addendum *to No. 4, in our last number, p.* 351.

I have since ascertained that with the six-feet speculum of the Earl of Rosse the brightest part of the great Nebula in the Triangle has been found to exhibit that marvellous spiral arrangement, to which we shall have to refer more fully hereafter. From a common centre spring four thick branches (with a mere suspicion of a fifth), somewhat like the arms of a cross, of unequal length, but each *curved in the same direction*.—Three observations, 1849; at the last of which the whole nebula was seen in "flocculi." No other portion of it seems to have any definite arrangement.

OCCULTATIONS.

Jan. 15th, π Piscium, 6 mag., will be hidden (at Greenwich) from 12h. 8m. till 12h. 44m. 19th, *l* Tauri, 5½ mag., from 12h. 2m. till 12h. 38m. 20th, χ^1 Orionis, 4½ mag., will disappear at 7h. 57m., and reappear at 9h. 13m. 24th, κ Cancri, 5 mag., at 6h. 30m. and 7h. 15m. respectively.

THE ACHROMATIC TELESCOPE.

The statistics of telescopic improvement and diffusion, if attainable, would form a curious subject of inquiry. Many an astronomer now living well remembers the day when an achromatic telescope of even 3¾ inches aperture was the largest that could be found as a portion of the optician's regular stock, and was by no means a cheap article, while those of greater dimensions were as scarce as they were costly. Now, those of the larger class are perhaps almost as numerous as the smaller ones were not many years ago; and it is at the same time a very gratifying consideration that this remarkable increase both in quantity and size has not been attended with any deterioration of quality, but rather the reverse. It may be doubted whether the high character which was ascribed to some of the earlier achromatics was other than comparative. They could not appear

excepting to advantage, even beyond their real deserts, after the cumbrousness and unwieldiness of the old refractors in whose place they succeeded; and those which are now in turn replacing them are certainly often of previously unattained excellence.

The great extension, however, of the means of observation has probably not been accompanied with an equal amount of information as to their nature; and many an amateur may be working with a tool, the principle of which he would find interesting if he did but understand it. Such information is certainly not essential to success, but as it involves some remarkable optical facts, our readers will perhaps not be displeased with a simple account of the construction of the ordinary achromatic telescope, as well as of its various modifications.

As we are not going to write a treatise upon Optics, some obvious preliminaries may be taken for granted; and we shall consider it to be generally understood that lenses of glass, or other transparent material denser than air, if their curves are predominantly convex, cause the rays of light to converge to a focus, where they form a picture of any object from which they have issued. A spectacle lens for an aged sight placed against the keyhole of a door of a darkened room, with a piece of white paper in its focus, gives a pleasing illustration of this, and every burning-glass is an instance of it, the little fiery spot being a picture of the sun, frequently attended by that of the bright clouds immediately around it. This focal image does not require a screen of paper to render it visible if the eye is placed at a suitable distance behind it, so as to receive the rays after they have crossed at the focus: it will then appear as a picture of the object beyond the lens, always inverted and enlarged, if the focus is sufficiently long; but, as the magnifying power thus obtained is inconsiderable, it is necessary to interpose between the picture and the eye a lens of short focus, or combination of lenses, which, acting precisely the same part as a microscope, will form a greatly enlarged image on the retina, and in so doing produce the simplest kind of telescope.* It is evident, therefore, that the quality of such a telescope, and, in fact, of all telescopes, will depend upon the accuracy of the focal image, every defect there being absolutely irremediable afterwards, and only made more conspicuous by each increase of magnifying; and accordingly the first object of the optician is to obtain as great perfection as possible in the formation of the picture in the focus. To produce this there must be good material, not only as transparent and colourless as may be, but (what is much more important) of uniform density throughout;

* This is not, however, the Galilean construction; which, though equally imple, does not admit of an equally ready explanation.

any irregularity in this respect having the effect of refracting the rays which encounter it more or less than their neighbours, and thus seriously impairing their accurate conveyance; good workmanship, too, is highly important—not merely brilliancy of polish, which, though very desirable, is not essential, but still more accuracy of form, any deviation from the correct curve being fatal to excellence. But, supposing all these combined, a single convex lens will not, after all, produce an accurate picture, or, optically speaking, form a good object-glass: and the cause of this imperfection may be well illustrated by means of a common reading or burning-glass. If we hold it in the sun and examine carefully, by receiving them upon a card or piece of paper, the appearance of the rays as they proceed towards and beyond the focus, we shall find, 1, that the circumference of the bright circle formed upon the paper is more luminous and sharply defined before reaching the focus than afterwards;—and, 2, that in the former case the circle is bordered by a narrow fringe of reddish orange, which beyond the focus is changed to a bright blue. Either of these peculiarities injures the distinctness of the picture, and each requires separate consideration.

As to the first defect, the condensation of light towards the edge of the rays converging to focus, it arises from the fact that it is not possible for a spherical surface, or any portion of one, to collect the rays passing through it in one point. The cause of this cannot be explained without a considerable knowledge of the mathematical law of refraction, upon which we must not here enter; it is sufficient to state that it requires that the rays refracted at a spherical surface should converge to foci nearer and nearer to that surface, in proportion as the surface is more highly inclined to the direction of the incident or emergent ray. Hence, the focus of the margin of a convex lens is perceptibly shorter than that of its centre—a fact which may be experimentally shown by so covering a reading or burning-glass with paper, that a narrow ring shall be left exposed all round the edge, and a small opening in the centre: if the lens is then held in the sunshine, and a card moved backwards and forwards through the focus (care being taken to keep both lens and card at right angles to the direction of the solar rays), it will be found that the ring formed by the marginal rays will converge to a point short of that reached by those from the centre, and that, being crossed by these latter rays, it will not be sharply defined; while the image from the central opening, formed further on and more distinct, will be surrounded with the re-opening luminous ring.* This defect,

* This experiment may be tried by candle-light, as a strong sunshine would be found very dazzling.

which is known by the name of "spherical aberration," or sometimes "aberration" alone, may also be illustrated by the diagram at p. 215 of our number for April, 1863, where a corresponding, though not precisely similar, defect is shown to be the result of employing a spherical surface in reflection.

The second source of error is of an entirely independent nature, arising from the unequal refrangibility of the rays of different kinds of light. If all the coloured rays which by their union compose whiteness, were acted upon to the same extent by refraction, they would still remain united under whatever circumstances refraction might occur, and no decomposition into colour could ever take place by any process of this kind. But such is not the case. Red light is invariably less bent from its course than yellow, yellow less than blue; and, therefore, refraction never takes place, even in the smallest degree, without a corresponding separation of the light into the primary colours of red, yellow, and blue, which by overlapping and partial combination produce the seven colours of the rainbow. The focus of the red light will for this reason be furthest from the lens, that of the yellow intermediate, and that of the blue shortest, the intervening spaces being filled up by various combinations of colour;* and whichever focus we may assume, the image there produced will not merely be deficient in due brightness, being formed by a portion only of the rays proceeding from the object, but will be bordered by fringes formed by the other colours converging to their own independent foci. The general cone of rays, as intercepted on a paper screen, will appear white, for though the whole mass of light is actually decompounded, an infinite number of cones of different colours being really produced by the infinite number of concentric rings of which the lens may be supposed to consist, yet as these all overlap and intermingle with each other, the whiteness is recomposed throughout. The outermost colour, however, having nothing to overlie it, crops out, as it were, in the form of a tinted border, and thus the general cone within the focus is fringed with the less rapidly convergent red, and beyond the focus by the more refracted blue, which having converged to a point nearer to the lens, but invisibly so, being neutralized in the general cone, crosses the general mass (confusing the other foci in its passage), and becomes outermost in the subsequent divergence.

This may be exemplified in an interesting manner by stick-

* The innermost focus is actually, as it is generally stated to be, that of the violet light; but we have taken no notice of it in the present explanation, partly because, according to Sir D. Brewster, it is not a primary colour, but compounded of the extreme red and blue rays, and partly because it is not of sufficient intensity to be recognized in these experiments.

ing upon a reading-glass a circular piece of paper of a somewhat smaller size as in the previous experiment, only omitting the central hole, and holding it up to the sun; the interior of the cone being thus stopped out, each side of the remaining ring will be found bordered with colour, and the red and blue fringes will change places in passing through the focus.* This separation into colour is technically termed "chromatic aberration," or more frequently "dispersion."

From the combination of these two sources of error, the focus of a simple refracting telescope, instead of being, as it ought to be, a single point uniting the whole body of converging rays, is a circle of appreciable magnitude, being the smallest common section of a number of cones meeting and crossing each other in different points, its size being determined by the distance between the extreme foci on either side of it: and consequently the image of every point in the object viewed will be a small, discoloured circle; and every outline in nature, which may be considered as made up of contiguous points, will be misty and ill-defined in the focal image, and exhibiting its imperfection still more in proportion as it is magnified by the eye-lens, will render telescopic performance very unsatisfactory. We must now consider what remedy may be applied to each of the defects whose united influence is so prejudicial.

1. The spherical error can be perfectly removed in theory, as was pointed out by Descartes, by making the exterior surface of the lens a portion of an ellipsoid or hyperboloid, instead of a sphere. But the extreme difficulty of working glass to any other than a spherical or flat surface rendered this discovery of no practical use: the amount of the aberration indeed, varying with the curves of the surfaces, may be much reduced by so combining them as to produce a *minimum* effect; but it never can be altogether annihilated.

2. Dispersion, which is the far more serious evil of the two, as introducing a much greater angle of deviation, is perfectly irremediable in its own nature, being an inseparable portion of the refraction by which the focal image is formed. Some transparent media possess a greater, others a less dispersive power; or, in other words, the interval between the red and blue foci differs somewhat according to the material of the lens: but the substances which occasion less proportional dispersion than glass are too expensive, or too unmanageable, to be employed with advantage, the difference, after all, being of no great amount.

* This experiment may be varied in a pleasing manner by covering the whole lens with a piece of paper, pierced with a great number of small holes, chiefly, however, towards the edges, as near the centre the discolouration will scarcely be perceptible.

Such are the defects of the simple refracting telescope; which depending, as we have seen, upon optical laws, and inherent in the construction, are irremediable, excepting by a modification of the construction itself. Fortunately for the interests of science, such a modification is possible, and has been effected with admirable results: but the explanation of it must be deferred to a future time.

LITERARY NOTICES.

Manual of the Metalloids, by James Apjohn, M.D., F.R.S., M.R.I.A., Professor of Chemistry in the University of Dublin. *Longmans.*—This work belongs to Galbraith and Houghton's series of scientific annuals, and is intended as a "Hand-book in Chemistry for Students in Medicine and Engineering." We should assign to it a much wider range of utility, as it appears to us an admirable introduction to chemistry, for students of all kinds. There is some inconvenience in publishing a manual of the "metalloids" by themselves; but we presume the chemistry of the metals, and of organized bodies, will follow sufficiently soon to enable the subscribers to Messrs. Galbraith and Houghton's series on "Experimental and Natural Science" to have a complete work on chemical science without much delay. Any division of substances founded on their chemical relations must necessarily partake of the incompleteness arising from imperfect knowledge; but as a provisional plan, little objection can be made to the formation of two groups, metals and metalloids, provided it is remembered that the division is purely empirical, and not intended to embody any well-established theory. According to this plan, opaque, highly lustrous bodies, which are good conductors of electricity and heat, are called *metals*, while the elementary gases, sulphur, selenium, tellurian, chlorine, bromine, fluorine, phosphorus, arsenic, boron, silicon, and carbon are lumped together under the designation *metalloids*.

Dr. Apjohn is too sound a thinker to be satisfied with this arrangement; but there can be no doubt, that in the study of chemistry the so-called metalloids should be presented to the learner before the metals, and in the order in which they occur in his book. The new manual consists of two portions—an introduction of 105 pages devoted to the theoretical portion of chemistry, and the main body of the treatise, in which the several metalloids and their compounds with each other are briefly but compendiously described. So far as the latter part is concerned, Dr. Apjohn appears merely as an able compiler, and we do not notice any particular novelty in the treatment; but the introduction constitutes a work of great merit, in which his skill as a teacher is conspicuously displayed. We doubt whether it would be possible to point to any other book in which so many important facts and doctrines of chemical philosophy are so briefly and so intelligibly explained. In this section we find the laws of combination, equivalent numbers,

atomic weights, chemical notation and nomenclature, the relations of atomic weights, law of volumes, atomic volume, the unitary system of atomic weights, isomerism, isomorphism, dimorphism, the reaction of bodies on each other, the views of Berthollet on the causes of decomposition—all presented in the clearest way. Dr. Apjohn works up logically from those simple ideas that are easily apprehended, to the more complex propositions assembled under the various heads we have cited, and it will not be his fault if those who read his book do not learn to *think*, as well as to recollect the bare facts of the science. We particularly admire the skill with which he has avoided the suggestion of fallacy that is inseparable from a metaphysical treatment of chemistry. He keeps strictly to facts, and when discussing theoretical views, such as those of Berthollet or Gerhardt, he is singularly fair, and ably discriminates between the judicious use of an hypothesis, and its premature acceptance, or rejection, upon insufficient grounds.

The Flora of Surrey; or, a Catalogue of the Flowering Plants and Ferns found in the County, with the Localities of the Rarer species, from the MSS. of the late J. D. Salmon, F.L.S. Compiled for the Holmesdale Natural History Club, Reigate, by James Alexander Brewer. *Van Voorst.*—Botanists and collectors will appreciate the great labour necessary for the production of this useful work; and we congratulate the Holmesdale Natural History Club on having made so important an addition to local natural history. The work is enriched by two large maps—one copied from a geological chart of the county, prepared by Joseph Prestwich, Esq., and the other arranging the county into botanical divisions corresponding with references in the text. An appendix exhibits the geological distribution of the plants; and there are two indexes—one giving the scientific names of orders and genera, and the other the common English names of species. On comparison, it appears that "the plants of Surrey are $\frac{4}{5}$ths of those of the United Kingdom;" that the Surrey Dicotyledons amount to $\frac{7}{11}$ths of those of the United Kingdom; the Monocotyledons to $\frac{2}{3}$rds, and the ferns and their allies to $\frac{1}{2}$ ditto.

Flora of Marlborough, with Notices of the Birds, and a Sketch of the Geological Features of the Neighbourhood; with a map. *Van Voorst.*—Mr. T. A. Preston states, in the preface, that this list is the result of five years of his own botanizing, and he invokes the labours of others to render it more complete. It has been especially compiled for the students of Marlborough College, and is confined to a circle having a radius of six miles from the town, of which a photographed map is given. The work affords another pleasing and useful instance of attention to local natural history; and we hope Mr. Preston will succeed in imparting to the Marlborough students a love of such pursuits.

Dictionary of Natural History Terms, with their Derivations, including the various Orders, Genera, and Species, by David H. M'Nicholl, M.D., Member of the Royal College of Physicians. *Lovell Reeve and Co.*—The enormous number of technical terms

and the prodigious quantity of compound words that make up the nomenclature of natural history, render it physically impossible that the whole of them could be comprised within the limits of a volume which many students could afford to buy, and therefore dictionaries compiled upon the principle of selection are to be commended. Dr. M'Nicholl has given as many words as can be printed in 584 fair-sized pages, in moderately small type. His collection is therefore very large, and his derivations will afford the clue to a great many analogous words not included in his list. We should be sorry to make an ungracious remark when an author has produced a really useful work at an immense cost of labour; but we should have thought it better for Dr. M'Nicholl to have omitted the botany altogether, as it has been already well done by Prof. Henslow, in his well-known *Dictionary of Botanical Terms*, and to have devoted all his space to zoology, which he could thus have rendered more complete. We are, however, bound to say that the work is a very valuable aid to the natural history student, who is continually perplexed by difficulties which it would instantly remove.

THE WARS OF WAPSBURG, by the author of the "Heir of Redcliffe," etc., etc. *Groombridge and Sons.*—The great popularity of the "Heir of Redcliffe" will ensure a welcome for this very pretty volume, in which the manners and customs of wasps are pleasantly described under the guise of a romantic story, of which the Princess Vespa is the heroine. The illustrations are numerous and elegant, and the binding is an admirable specimen of the way in which the rich, soft appearance of morocco can be imitated in cloth.

THE DESK-BOOK OF ENGLISH SYNONYMES, by JOHN SHERER.—*Groombridge and Sons.* In this work, which the author avows to be based upon the labours of Crabbe, Richardson, and Webster, a very ingenious plan is followed, by which an unusual quantity of information is compressed in a very small space. Every word contained in the book as a "synonym" is placed in an alphabetical index referring to the page in which it will be found. By this means a great deal of repetition is avoided, and a very large body of synonyms, with the author's explanations, are given in a quarter of the space that must be devoted to them on the ordinary plan. The way to use the work is to refer to the index for the word required, and then by casting the eye down the page indicated, it will be found either as the initial word of a paragraph, or as one of its so-called synonyms. This process does not take so long as turning over the pages of a more bulky book, and will augment the utility of Mr. Sherer's labours. It is of great importance to correct writing and speaking, that the various shades of meaning embodied in what are popularly, but often incorrectly, termed synonymous words, should be accurately appreciated, and dictionaries like the "Desk-Book" will materially assist in diffusing the requisite information. We should have recommended a little more attention to primitive and derivative meanings; but the book bears evidence of much thought and reading, and the authorities followed by Mr. Sherer are in good repute.

PRACTICAL HYDROPATHY, by JOHN SMEDLEY CAUDWELL, is an elaborate account of the innumerable ways in which water may be applied as a remedial agent.

CONTRIBUTIONS TO THE ICHTHYOLOGY OF NOVA SCOTIA, by J. MATTHEW JONES, F.L.S. Privately printed. Halifax, N.S. Part I.—Mr. Jones is engaged in the useful task of ascertaining what species of fish on the N.E. coast of America are identical with those of Europe, and in this paper he shows the effect of oceanic currents in enabling certain fishes to make long journeys, and of floating masses of sea-weed in transporting littoral species, which would have not been able to migrate without such locomotive aid.

ENGLAND'S WORKSHOPS, by DR. G. L. M. STRAUSS, C. W. QUIN, F.C.S., JOHN C. BROUGH, THOMAS ARCHER, W. B. TEGETMEIER, W. J. PROWSE. *Groombridge and Sons.*—It was a very good idea to collect together in one book a popular and readable account of many of the principal "workshops" in which manufacturing skill and industry are displayed. The establishments described range under the heads of "Metal Workshops," "Chemical Workshops," "Glass Workshops," "Provision and Supply Workshops," and "Domestic Workshops," the last title not being very appropriate, as cotton goods and pianofortes are not more "domestic" than Price's candles, or Birmingham trays. The number of establishments visited and described is forty-one, and the information, which is very pleasantly given, takes a very wide range. There are very few readers who will not be interested in these pages, but we especially commend the work to young persons entering upon the active duties of life, as they will glean from it much valuable information to direct their choice of an occupation suited to their capacities and tastes. It might also be made a very useful book for class reading in schools, as it goes deep enough into a host of technical and scientific questions to lay a good foundation, and is written in a lively, entertaining style. The enormous number of occupations requiring a large amount of scientific and technical knowledge, is one of the most remarkable features of our age, and we cannot read an account of our national labours in iron, steel, brass, and other metals, or of our great glass works and chemical factories, without being convinced that industrial necessities are compelling a very high degree of education, and leaving comparatively small chance of success for those who neglect the diligent cultivation of the mind.

OUR ENGLISH LAKES, MOUNTAINS, AND WATERFALLS, as seen by WILLIAM WORDSWORTH. Photographically illustrated. Small 4to. *A. W. Bennett.*—The admirers of Wordsworth—and they are found in all true English homes—will thank Mr. Bennett for this splendid volume. The selections from the poet, who best understood our "English lakes, mountains, and waterfalls," are very numerous, and made with great judgment, while the photographs, thirteen in number, admirably taken by Mr. Ogle, bring before us the varied beauties of the district in which he lived and wrote. The Fall of

Rydale, Dungeon-Ghyll, Langdale, Honister Crag, and Aira Force are among the most striking of the exquisite views; but the calm repose of Grasmere, the variety of Rydale Water, and the stern, feudal physiognomy of Brougham Castle, the old home of the Cliffords, all help to connect the rhyme of the poet with the objects that inspired his undying verse. We ought also to put in a word of special commendation for the initial letters and tail-pieces, which exhibit an unusual elegance of fancy, combined with artistic skill in dealing with floral forms. As "intellectual observers," we are glad to find the revival of a taste for beautiful books. Cheapness is all very well in its way, but every one, who can afford it, should endeavour to possess some specimens of favourite authors worthily treated in all that concerns paper, binding, typography, and illustration; and for those who share this feeling the volume before us has been judiciously produced.

Ruined Abbeys and Castles of Great Britain and Ireland, by William Howitt. Second Series. The photographic illustrations by Thompson, Sedgfield, Ogle, and Hemphill, fcap. 4to. *Alfred W. Bennett.*—In dealing with architectural relics of the olden time there is nothing like photography for ensuring that accuracy which is so essential to the value of archæological illustrations, and the specimens of sun pictures with which this work is adorned possess a high degree of excellence. In the frontispiece we look through the trees of the village at Kenilworth Castle, and the introduction of the landscape brings out in a striking way the magnitude and power of the grand baronial pile, associated with so many proud reminiscences of British history, associated also with much folly and crime. "Mervyn's Tower," in the same building, is admirably given, and we almost expect to see the mantling ivy wave its branches as the wind passes the window arch. Another striking picture is Whitby Abbey, one of the finest of our ecclesiastical ruins. We recognize also the elegance of Netley, and regret that tradition has done less than vegetation to add a charm to its beautiful remains. Far different is it with Croyland, whose west front makes an admirable picture, or with Lindisfarne, both of which are well known in story, and whose likeness many will rejoice to possess. Among less known ruins, we notice a highly pictorial photograph of Castlemere Priory, in Norfolk, the west front of which is a model of Norman skill. Dryburgh Abbey, so well known to the readers of Scott, affords another romantic view, quite in keeping with the sad end of the "Lady of Smailholme," as told in the "Eve of St. John." Ireland is not forgotten in the series, as we have a fine round tower in the "Rock of Cashel," and a solemn ruin in Holy-cross Abbey. The other illustrations—each worthy of separate praise—relate to Caernarvon Castle, Tynemouth Priory, Hurstmonceux Castle, Richmond Castle, Byland Abbey, Jedburgh Abbey, and Cahir Castle. There are in all twenty-six photographs, and every chapter begins with an ornamented letter, and ends with a tail-piece harmonizing with the subject of the work. Mr. Howitt has supplied a series of interesting notes on the several places, and although we should not

like to endorse all his views of history and biography, he has performed his task in a manner that will make this beautiful book generally acceptable. The binding is very handsome, and in the centre of each cover a circular photographic view is excellently introduced. This work, like the preceding, will form an admirable present, and worthily take its place on the drawing-room table of "Homes of Taste."

PROCEEDINGS OF LEARNED SOCIETIES.

WEST BRIGHTON MICROSCOPICAL CLUB.

At a meeting of this scientific body, held on the 23rd of November last, Dr. William Addison, F.R.S., President, in the chair, the subject of Human and Animal Entozoa was discussed, especially in relation to the question as to the existence of a true nervous system in the round-worms (*Nematoda*), and as to the mode in which these parasites gain access to our bodies. Dr. Cobbold, F.L.S., of the Middlesex Hospital, exhibited the following helminths:—From the human body *Distoma heterophyes* (Ægypt); *Bilharzia hæmatobia* (Ægypt), *Ascaris lumbricoides* (England), *A. mystax* (England), *Trichocephalus dispar* (Scotland), *Trichina spiralis* (Germany), *Oxyuris vermicularis* (England), *Tænia solium* (Germany), *T. mediocanellata* (Germany), *T. nana* (Ægypt), *Bothriocephalus latus* (Switzerland), *B. cordatus* (Greenland), young of *Filaria medinensis* (India), *Cysticercus cellulosæ* (England), Scolices of *Tænia echinococcus* (England).

From animals:—*Distoma Bosci*, from an American snake; *D. coronarium*, from an alligator; *D. clavigerum*, from a frog; *D. constrictum*, from a turtle; *D. compactum*, from an Indian ichneumon; *D. varicum*, from the salmon; *Bilharzia magna*, from an African monkey; *Distoma lanceolatum*, from the ox; *Fasciola hepatica*, from the sheep; *Ascaris megalocephala*, from the horse; *A. mystax*, from the cat; *A. osculata*, from the seal; *A. retusa*, from the armadillo; *A. capsularia*, from the salmon; *Trichosoma longicolle*, from the capercaillie; *Trichocephalus affinis*, from the giraffe; *Strongylus paradoxus*, from the peccary; *Sphærularia bombi*, from the bee; *Echinorhynchus proteus*, from a salmon; *E. porrigens*, from a whale; *E. anthuris*, from the lesser newt; *Tænia pusilla*, from a rat; *T. uncinata*, from a shrew; *T. cucumerina*, *T. cœnurus*, *T. marginata*, and *T. serrata*, from the dog; *T. elliptica*, from the cat; *T. farciminalis*, from a fieldfare; *Diphyllobothrium stemmacephalum*, from the porpoise; *Pentastoma tænioides*, from a dog, and *P. multicinctum*, from a serpent; *Cysticercus* of *T. mediocanellata*, from a calf; *Echinococci*, from a lemur; adult and embryonic *Trichinæ*, from the pig; *Cysticercus fasciolaris*, from a mouse; *C. pisiformis*, from the rabbit; *C. talpæ*, from the mole; *Cœnurus cerebralis*, from the sheep; and Scolices of *Tetrarhynchus reptans*, from a sunfish.

Mr. Hennah, Hon. Secretary, also exhibited a species of *Strongylus*, from the goose; and Dr. Dawson showed some *Echinococci*, derived from a cyst in the human orbit.

ROYAL SOCIETY.—*Nov.* 30.

In his annual address on the anniversary meeting of the Royal Society, the president, Major-General Sabine, called attention to the proposed establishment of a telescope of great optical power at Melbourne, and suggested that another advantageous situation for observing the southern nebulæ would be in the Nélgiris, at elevations of several thousand feet into the clearer strata of the atmosphere.

After alluding to the measurement of the arc of the meridian at Spitzbergen, which the Swedish government propose to undertake, Gen. Sabine called attention to the circumstance of several glass bottles with closed necks having been found on the shores of the west coast of Nova Zembla. As these were conjectured to have some connection with the missing ships of Sir John Franklin, the Royal Society instituted inquiries into the subject, and eventually traced the bottles to a recent manufacture in Norway, where they are used as floats to the fishing-nets employed on the coast. These floats, accidentally separated from the nets, had been carried by the current which sets along the Norwegian coast round North Cape, and thus proved the continuation of the current to Nova Zembla. The Swedish expedition above alluded to discovered several of these bottles on the northern shore of Spitzbergen, some bearing the names of the Norwegian makers, thus supplying evidence, of great geographical value, of the extension of the Norwegian current to Spitzbergen, either by a circuitous route past the shores of Nova Zembla, or possibly by a more direct course which has not at present been traced.

In alluding to the laborious investigation of the Austrian commission on the relative advantages of gun-cotton and gunpowder for the purposes of warfare, Gen. Sabine summed up the results as follows:—

The absence of smoke, and the entire freedom from fouling of the gun, are points of great moment in promoting the rapidity of firing in casemates and between decks of ships of war. To these advantages must be added the innocuous character of the products of combustion in comparison with those of gunpowder, and the far inferior heat imparted to the gun by rapidly repeated discharges. Again, with equal projectile effects, the weight of the gun-cotton is only one-third that of gunpowder, and the recoil of the gun two-thirds, and the length of the gun admits of a diminution of nearly one-third.

Other advantages determined by the Austrian artillerists bring the power of modifying the explosive energy by varying the mechanical structure of the cartridge and the size of the chamber in which it is fired; and the fact that being a perfectly definite chemical compound, it may be stowed in damp situations, or even sub-

merged without injuring its original properties, remaining unchanged after drying in the open air, and at ordinary temperatures. The great drawback of its liability to spontaneous combustion having now been proved to depend on imperfect manufacture, and to be altogether removed when suitable provisions are adopted in its manufacture.

At the conclusion of the anniversary meeting, the Copley medal was presented to the Rev. Adam Sedgwick, for his discoveries in geology. Royal Society's medals to the Rev. M. J. Berkeley, for his researches in cryptogamic botany, and to Mr. J. P. Gassiot, for his discoveries in voltaic electricity.

ROYAL SOCIETY OF LITERATURE.—*Nov.* 25.

Ancient Knowledge of African Lakes.—Mr. Hogg read a paper descriptive of the old maps of Africa, showing that our recently acquired knowledge was known to the ancient geographers. In a map in the possession of the College de Propagandâ Fide, at Rome, probably copied from an Arabian one of the ninth century, the Nile is represented as rising from a lake on the equator.

In a map of J. Senex, F.R.S., dedicated to Sir I. Newton, Lake Nyanza is placed in the same position as in Capt. Speke's recent map, and in Walker's map Lake Zambre is laid down in the position of the recently discovered Lake Tanganyiake. It is singular that since the time of Senex the maps have been published with continually increasing inaccuracies until the promulgation of the recent discoveries of the several African explorers. It is presumed that the information contained in these old maps must have been obtained from the Portuguese traders, who penetrated long distances into the interior.

ETHNOLOGICAL SOCIETY.—*Dec.* 9.

The Weddos, or Widdos, of Ceylon.—A description of this remarkable tribe, living in the jungle in the interior of Ceylon, was read before the Society. It was written by one of the Tamil natives. The Weddos are generally supposed to be the direct descendants of some royal families or chiefs, who were driven into the forests of the interior when the island was invaded, nearly 2200 years since.

The descendants of these families have remained perfectly distinct, not associating with the other races of the island. The males, however, exchange wax, ivory, and dried venison for salt, and also for farinaceous substances, such as arrowroot. They capture their game and defend themselves by the use of the bow and arrow, being sufficiently expert to destroy their enemies at a distance of sixty yards. They are quite ignorant of the use of firearms. Within a comparatively recent period they have commenced to cultivate the land, but they subsist chiefly on the flesh of wild animals, which they preserve in honey, and in times of scarcity they will eat decayed

wood soaked in honey. Living at a distance from the sea-coast, salt can only be obtained by them through the medium of barter, and they place a higher value on it than on any other article. They are described by the author as a miserable-looking race, speaking a dialect of the ancient Cingalese language, mixed with Talengo, and which is not understood by the Cingalese generally. Their religion consists in the worship of the tortoise Ebba, to whom offerings are made on the occasion of childbirth and sickness. If the sick person, in whose behalf the offerings are made, does not speedily recover, he or she is abandoned to die alone, the body remaining unburied. The most singular circumstance connected with the tribe is the total seclusion of the women; strangers are not permitted to approach their villages, and a father does not ever see his daughter after she has grown up, nor does a mother ever see her male children after they have attained the age of manhood.

At the time of childbirth the husband leaves his wife to the care of another female for a few days, the nurse leaving before the return of the father. Formerly the tribe appeared not to employ clothing, but more recently they have commenced its adoption.

ROYAL GEOGRAPHICAL SOCIETY.—*Dec.* 14.

Geography of Formosa.—Mr. Swinhoe, Consul at Tai-Wan-Foo, forwarded an interesting paper of notes on the Island of Formosa, which is now a Chinese province. Formosa is of very difficult access, owing to the absence of harbours, the rocky character of the coast, and the strong set of the great equatorial current, which was described by Admiral Collinson as flowing near the island at the rate of four and a half to five miles an hour.

Formosa produces excellent lignite coal, tea, jute, rice, sugar, and the general productions of a sub-tropical region. The coal was described by Admiral Collinson as being worked by means of adits, where it cropped out on the surface, no shafts being sunk. The south cape of the island was described by Sir Harry Parkes as being inhabited by a tribe of aboriginal savages, numbering about 200 or 300 people, who destroyed all strangers who were wrecked on their part of the coast; nor were those who fell into the hands of the Chinese in a much better condition, for of the crews of two large vessels wrecked on the coast in 1842, numbering 297 persons, all but twelve were judicially murdered in cold blood in the capital. Since then the island has been opened to British commerce by the Elgin treaty, and a brisk trade is being carried on by steamers between Formosa and Hong Kong.

NOTES AND MEMORANDA.

The Amœban Rhizopods.—Dr. Wallich continues, with amazing patience, his elaborate study of amœban rhizopods, and we extract a few facts and opinions from his last paper in the *Annals of Natural History*. He has, amongst other things, ascertained that the amœbæ can, at least temporarily, assume the form of *actinophrys*. He points out three modes by which new amœbæ are formed by *acts of reproduction*.—1. The extrusion from the parent of a minute but perfect offspring. 2. Development from one of the sarcoblasts, or acapsular masses which are formed within the parent previous to, or during, encystation. 3. By development from each granule of the acapsular nuclear mass, on the disruption of the latter. He considers these creatures hermaphrodite, and that the preceding generative acts are distinct from the multiplication of the individual, or vegetative repetition of the species by fission or germination, which last process he does not vouch for on his own authority, except as regards actinophrys. He shows that sarcoblasts of the amœbæ, which are very small, do manage to get into frustules of diatoms, and he thinks they may get into confervæ, and undergo a development which has hitherto been misunderstood. He likewise proves that these sarcoblasts preserve their vitality under prolonged desiccation.

Electricity and Asthma.—M. Poggioli describes to the French Academy the success which he experienced in treating asthma by electricity. He considers this remedy applicable to true asthma only, which is a nervous disorder of the respiratory apparatus, usually occurring periodically and in paroxysms, and not to asthmatic symptoms resulting from heart disease or pulmonary emphysema.

Effects of Consanguineous Marriages.—M. Balley has called the attention of the French Academy to a remarkable result of a very singular marriage of this kind. He says, "the father and mother enjoyed good health; the father was born in lawful wedlock; the mother, somewhat older, came from a foundling hospital. From this union resulted in succession four infants, stillborn; the fifth is deaf and dumb in an asylum at Rome; the sixth is a dwarf, and the seventh has not at present exhibited any peculiarity. It is now known that the individuals, so afflicted in their descendants, are brother and sister, children of the same father and mother. The girl, born before marriage, was deserted by her parents, was never reclaimed by them, and was ignorant who they were." M. Balley proposes that special inquiries should be made in deaf and dumb asylums concerning the relationship of the parents of the unfortunates. In Rome he finds out of thirteen cases of persons born deaf and dumb, three were offspring of consanguineous marriages, one being connected with the deplorable story we have just cited.

An Artificial Tongue.—M. Maisonneuve, Surgeon of the Hôtel Dieu, describes in *Cosmos* how he removed from a patient the whole of a tongue afflicted with cancer, by means of which he terms *cauterisation en flèches*. He perforated the tongue with eight of his cauterizing arrows (*flèches*), so as to cause all the affected portions to slough off in one mass. His patient, after the removal of the tongue, could neither swallow nor speak, but performed both those functions on being supplied with a gutta-percha tongue of the natural size.

Spontaneous Generation Controversy.—The dispute between M. Pasteur, on one side, and M.M. Pouchet, Joly, Musset, and other heterogenists, on the other, still rages in the French Academy. The latter bring air from the Alps in bottles, and find it capable of giving rise to infusoria in solutions that have been boiled. The former admits that portions of air from Alpine summits occasionally contain germs, as proved by his own experiments, and he points out precautions that seem to have been neglected by his antagonists. The balance of experimental accuracy seems decidedly with M. Pasteur, but the continuance of the discussion cannot fail to enlarge our knowledge of the conditions under which infusoria appear. M. Flourens proposed and the Academy agreed to appoint a commission before which the heterogenists should be requested to repeat the experiments by which they think they invalidate M. Pasteur's conclusions.

ATMOSPHERIC CURRENTS AND SHOOTING STARS.—M. Chapelas, in a paper read before the French Academy, alleges grounds for believing that the movements of shooting stars are effected by atmospheric currents occurring in the higher regions to which our air extends; and he considers that these bodies may act like weathercocks and anemometers, giving us information concerning the direction and force of the winds that influence their proper motions.

BACTERIUMS AND TYPHOID FEVER.—Professor Sigri calls the attention of the French Academy to the presence of these infusoria in the blood of a man who died of the above fever in the hospital of Sienna. This fact is very curious, taken in connexion with the researches we have previously published (INTELLECTUAL OBSERVER, October, 1863, page 177).

KIRCHHOFF ON SUN SPOTS.—The memoirs of the Berlin Academy contain M. Kirchhoff's papers, of various dates, on the Solar spectrum, and it appears that he attributes sun spots to a cooling action exerted by clouds which obstruct the radiation of heat from the solar surface (which he imagines incandescent), and thus reduce a portion of the atmosphere immediately over the cloud to a temperature below the point necessary to render it luminous. The spots, according to this hypothesis, are portions of solar atmosphere cooled below red heat, and above them, portions which have been cooled somewhat less constitute the penumbra. It may be doubted whether this explanation will be found to fit the actual phenomena. Such coolings would cause powerful and peculiar currents. Do exactly such currents occur as would result from M. Kirchhoff's supposition, and are they evidenced by the behaviour of the spots?

DISTANCE OF SIRIUS.—As Sirius now forms a magnificent object in our heavens, we transcribe from *Cosmos* a few interesting remarks by M. Camille Flammarion, who says, "thanks to the labours of Sir John Herschel, we know that the absolute intensity of the light of Sirius has been estimated at 224 times that of the sun, and that its parallax, amounting to 0''·23, gives for its distance from the earth the probable number of 52 billions of leagues. It follows that we do not see the Sirius of to-day, but of twenty-two years ago: the ray of light that we receive to-day having been emitted by the star about 1840."

AZULENE.—Mr. Septimus Piesse has discovered a substance to which he has given this name, in several "ottos," or essential oils. It is a blue liquid, and produces a blue vapour on ebullition. It is soluble in fatty and volatile oils, and in most liquids except water. It bears a temperature of 700° or 800° F. in a sealed tube without alteration, and only the strongest chemicals, with the aid of heat, effect its decomposition. Sir D. Brewster reports that two blue oils containing azulene—*Matricaria chamomilla* and *Achillea millefolia*—absorb the light between lines A and B of the spectrum more powerfully than in the portions adjacent to them. Blue otto of chamomile yields one per cent.; otto of wormwood three per cent., and otto of patchouli six per cent. of azulene.

MR. HIGHLEY'S LANTERN POLARISCOPE.—Mr. Samuel Highley has just introduced a form of polariscope easily used with a magic lantern, and capable of producing a variety of beautiful and startling effects. The light is polarized by reflection from a bundle of glass plates placed at a suitable angle, and the general arrangements are sufficiently simple and economical to be of wide use both for the purposes of instruction and entertainment.

M. PASTEUR ON WINE-MAKING.—M. Pasteur finds that grape-must does not contain oxygen gas in solution, but only carbonic acid and nitrogen; that if the must is left in contact even with a large surface of air it does not oxydize, so that until fermentation begins, it contains only carbonic acid and nitrogen; but the oxygen of the air combines with it in proportion to its dissolution with oxydible principles naturally contained in grape juice. The combination of the oxygen is not, however, so rapid but that we may find the gas in solution some hours after the must has been agitated in contact with air. The oxydation modifies the colour of the wine, giving the yellow tint to the juice of white grapes, and browning that of the red, and it also appears connected with the formation of the ether of wine. Guy Lussac showed that oxygen was necessary to the fermen-

tation of grape juice; and M. Pasteur states that if the must is artificially aërated it ferments much more rapidly. He considers that in certain cases this artificial aëration might be beneficially employed, especially when wine remains too sweet after a tumultuous fermentation. When wine is put in casks the oxygen of the air reaches it through the wood, with more or less rapidity, according to the thickness of the staves, the warmth of the cellar, etc. Without this action M. Pasteur considers it would remain *new* wine, green, harsh, and not fit to drink. When the wine is bottled the facility for oxydation is greatly diminished. It might be possible to accelerate the oxydation in casks so as to ripen the liquor sooner, but, as M. Berthelot has shown, rapid oxydation produces mischievous effects.

The 2nd and 3rd December Storm.—M. Marié-Davy states that on the 1st December this great storm was 50 or 60 leagues from the N.W. coast of Ireland, at 8 a.m. On the 2nd December, at the same hour, its centre was at Shrewsbury, and the cyclone, instead of its following its customary march towards the east, was bent back towards the south. In Paris the barometer fell with extreme rapidity, and the tempest raged in that city with great violence. Twice since the first fortnight in November a hurricane traversed England and France almost from north to south, and it seemed as if this were about to happen the third time, when about one o'clock the barometer rose as quickly as it fell, and the storm took a northward course. The southern movement was not, however, completely arrested, and a violent wind blew in the gulfs of Lyons and Genoa, and in the Adriatic. On the 3rd December, the centre of the hurricane in England was near York, from whence it moved in its habitual course towards the east. On the 4th, it was a little north of Copenhagen; on the 5th, it appeared to quit the Baltic, between Libau and Königsberg, after which its course was not traced at the date of his paper. The centre of the hurricane moved with a velocity of ten leagues an hour, being the rate at which slight cyclones often move across Europe. It will thus appear that the cause of their progress is independent of their violence. M. Marié-Davy considers that this storm may have started from the Gulf of Mexico, and he suggests that if a telegraph cable should ever join Europe and America, and pass the Azores, those islands would make an excellent station, from which we might have two or three days' warning of the coming of great storms.—*Comptes Rendus.*

M. Blondeau on Acetification.—This observer tells us that if casein be added to a saccharine solution, mycoderms are developed, and acetic acid formed. Referring to M. Pasteur's statements concerning the acetifying action of certain mycoderms, M. Blondeau remarks that his experiments show that the plants perform this function only when they assume a membranous form, and that the property of taking oxygen from the air, and with it transforming alcohol into vinegar belongs to the membrane as such, and is not a physiological action.—*Comptes Rendus.*

Supposed New Planet.—It was announced that M. Schmidt had discovered a new planet on the 13th November. He found it a little east of η in the Pleiades, and it appeared of 10th to 11th magnitude. In a subsequent number of the *Astronomische Nachrichten* that astronomer states that, according to the supplement to the *Nautical Almanack* for 1866, the little body appears to be Hygeia. On the 18th November it was very faint, and about 12th magnitude.

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